CO 600 NP
LINC TAPE SYSTEM
FOR NOVA COMPUTERS

REFERENCE MANUAL

COMPUTER OPERATIONS, INC.
10774 TUCKER STREET
BELTSVILLE, MARYLAND 20705

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DOC. NO. 112

TABLE OF CONTENTS

REFERENCES

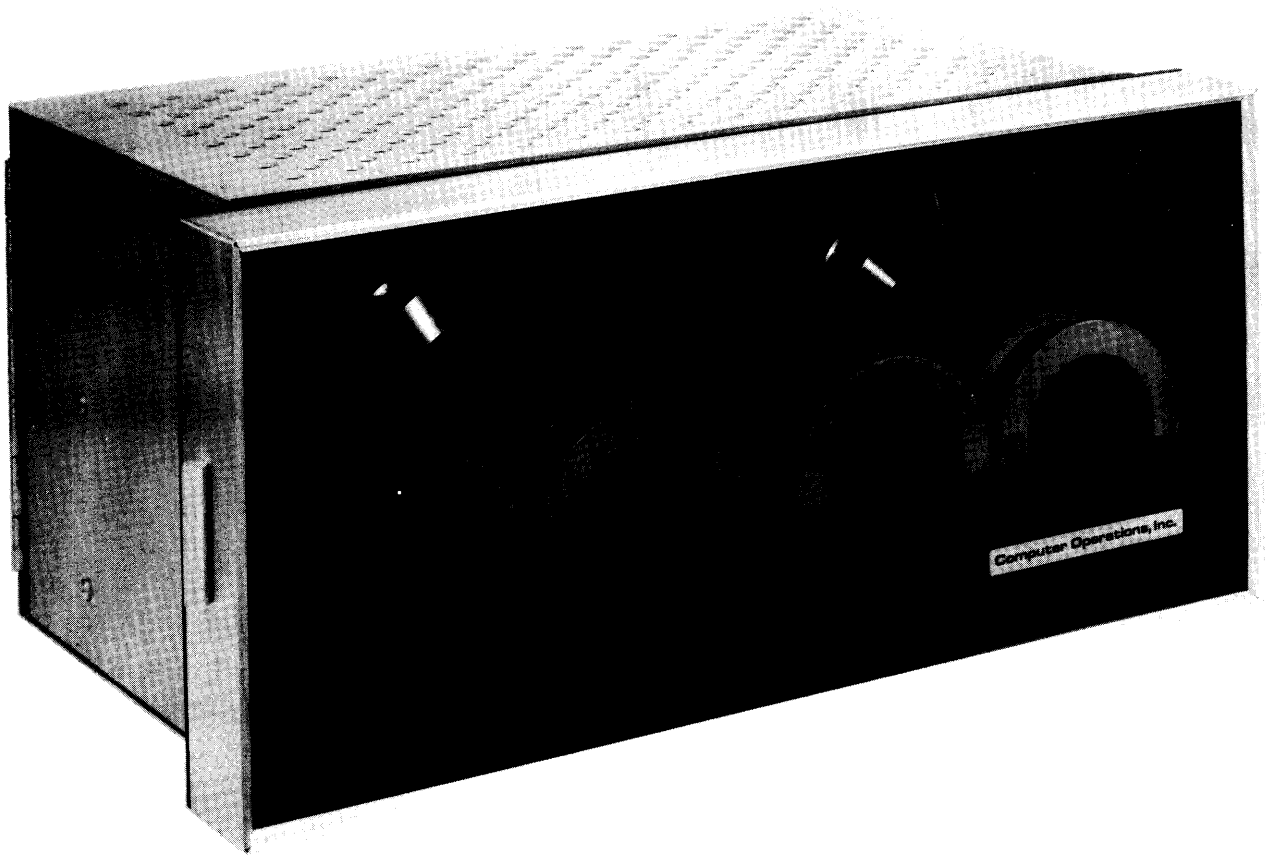
(1) "HOW TO USE THE NOVA COMPUTERS", DATA GENERAL CORPORATION, DG-NM

(2) "SCHEMATIC DIAGRAMS OF THE LINCTAPE/NOVA SYSTEM", COMPUTER OPERATIONS, INC.

COI DR. NO	SCHEMATIC
D-1Ø23Ø-Ø1	LINCTAPE MASTER CONTROLLER (D-1Ø144-Ø1 FOR S/N BELOW 1Ø16)
B-1Ø164-Ø1	LINCTAPE DRIVE CONTROL BOARD
D-1Ø198-Ø1	LINCTAPE READER/WRITER BOARD (D-1Ø232-Ø1 FOR S/N BELOW 1Ø16)
D-1Ø244-Ø1	LINCTAPE POWER SUPPLY

CO 600

LINC TAPE SYSTEM



INTRODUCTION

THIS MANUAL IS DESIGNED TO ASSIST OPERATORS, PROGRAMMERS, AND MAINTENANCE PERSONNEL IN THE USE OF THE LINCTAPE SYSTEM WITH A NOVA, SUPER NOVA, NOVA 800 SERIES, OR NOVA 1200 SERIES COMPUTER. A KNOWLEDGE OF THE OPERATION OF THE NOVA IS ASSUMED.

NO DATA GENERAL OPTIONS, EXCEPT THE I/O CONNECTOR ARE REQUIRED. HOWEVER, IT IS ASSUMED THRUOUT THIS MANUAL, THAT A TELETYPE * OR EQUIVALENT I/O DEVICE IS AVAILABLE. THE I/O CONNECTOR IS STANDARD ON THE 1210, 1220, AND 820 NOVA COMPUTERS.

* TELETYPE IS A TRADEMARK OF THE TELETYPE CORPORATION.

1.0 GENERAL DESCRIPTION

THE CO-600-NP LINCTAPE SYSTEM CONSISTS OF TWO (OR MORE) DRIVES AND A COMMON ELECTRONICS SYSTEM. EACH DRIVE HANDLES ONE REEL OF LINCTAPE.

EACH TAPE IS DIVIDED INTO SECTORS OR BLOCKS. THERE ARE 400 (620 OCTAL) SUCH BLOCKS PER TAPE, NUMBERED 0 THRU 399. EACH BLOCK CONTAINS 256 WORDS OF 16 BITS EACH. EACH BLOCK IS ADDRESSABLE AND THE TRANSFERRING OF DATA (READING OR WRITING) IS DONE ONE OR MORE BLOCKS AT A TIME. THUS, LINCTAPE IS MORE AKIN TO A DISC THAN IT IS TO INDUSTRY COMPATIBLE TAPE.

FOR INSTANCE, ASSUME THAT IT IS DESIRABLE TO SAVE A DATA BUFFER THAT EXISTS IN CORE FROM LOCATION 3000 THRU 3777 (OCTAL). IT CAN BE WRITTEN OUT ONTO LINCTAPE AS FOLLOWS:

```
        SUB   0,0
        DOB   0,LINC    SELECT DRIVE NO 0
        LDA   0,BLKNO   LOAD AC0 WITH 1ST BLOCK NUMBER
        LDA   1,NBLKS   LOAD AC1 WITH NUMBER OF BLOCKS
        LDA   2,FCORE   LOAD AC2 WITH 1ST CORE LOCATION
        JSR@  WLINC     JUMP TO THE WRITE UTILITY SUBROUTINE
         --
         --
BLKNO:  100
NBLKS:  2
FCORE:  3000
WLINC:  X7406
RLINC:  X7403
```

THIS ROUTINE WILL WRITE 2 BLOCKS (1000 OCTAL WORDS), STARTING AT CORE LOCATION 3000, ONTO THE LINCTAPE THAT IS ON DRIVE 0, STARTING WITH BLOCK NUMBER 100.

TO READ THE DATA BACK INTO CORE, THE SAME PROCEDURE WOULD BE USED, EXCEPT THAT THE LAST INSTRUCTION WOULD BE "JSR@ RLINC".

ONE OF THE ADVANTAGES OF LINC TAPE OVER INDUSTRY COMPATIBLE TAPE SYSTEMS IS THE ABILITY TO OVER-WRITE A BLOCK. THE SELF-SYNCHRONIZING FEATURES OF LINCTAPE ALLOW INFORMATION TO BE READ, UPDATED, AND RE-WRITTEN BACK ON THE SAME PLACE IN TAPE.

AMONG THE MAJOR USES OF LINCTAPE ARE:

1. BOOTSTRAPPING. THIS ALLOWS STARTING THE COMPUTER FROM SCRATCH BY LOADING THE LINC UTILITIES AND OTHER DESIRED PROGRAMS INTO CORE.

2. LIBRARY STORAGE. LIBRARY PROGRAMS, SUCH AS THE ASSEMBLER DEBUG ROUTINES, AND DIAGNOSTICS, CAN BE STORED ON TAPE AND LOADED INTO CORE QUICKLY AT ANY TIME.

3. PROGRAM STORAGE. USER PROGRAMS CAN BE STORED ON LINCTAPE FOR RAPID, DIRECT ACCESS WHEN NEEDED. THREE PARAMETERS: BLOCK LOCATION, CORE LOCATION, AND NUMBER OF BLOCKS WILL SPECIFY ALL THAT IS NEEDED TO LOAD ANY OF THE PROGRAMS.

4. PROGRAM DEBUGGING. WHEN DEBUGGING PROGRAMS, THE CURRENT PROGRAM CAN BE SAVED ON LINCTAPE. IF THE PROGRAM DESTROYS CORE, IT CAN BE QUICKLY RELOADED. IF IT REQUIRES UPDATING, IT CAN BE LOADED INTO CORE, UPDATED, AND WRITTEN BACK ONTO TAPE EASILY. IF EXPERIMENTAL PROGRAM MODIFICATIONS ARE TO BE TRIED, THE ORIGINAL, AND LATER ITERATIONS, OF THE PROGRAM CAN BE SAVED.

5. PROGRAM OVERLAY. LARGE PROGRAMS CAN BE BROKEN INTO SMALLER SECTIONS AND LOADED INTO CORE A SECTION AT A TIME. THUS IT IS OFTEN POSSIBLE TO UTILIZE A MACHINE WITH LIMITED CORE TO RUN LARGE PROGRAMS USING LINCTAPE.

6. DATA STORAGE. DATA BLOCKS CAN BE STORED ON, OR READ FROM LINCTAPE IN THE STANDARD MANNER. WRITING "IN PLACE" OFTEN ALLOWS THE USE OF ONE TAPE, INSTEAD OF THE USUAL TWO THAT ARE REQUIRED FOR INDUSTRY COMPATIBLE SYSTEMS.

7. DATA MERGING. MERGING TWO DATA BUFFERS CAN USUALLY BE DONE WITH ONE DUAL LINCTAPE SYSTEM, RATHER THAN THREE INDUSTRY COMPATIBLE SYSTEMS.

2.0 SPECIFICATIONS

2.1 SYSTEM

DUAL TAPE DRIVE
EXPANDABLE TO 16 DRIVES (8 DUAL)
60 IPS TAPE SPEED IN EITHER DIRECTION
BI-DIRECTIONAL BLOCK SEARCH AT FULL SPEED
UPDATE ANY SECTOR(S) DIRECTLY
WRITE PROTECT ON EACH DRIVE
25 SECONDS END TO END TRAVERSE TIME
8.5 SECONDS AVERAGE ACCESS TIME
130 MS START/STOP/REVERSE TIME
16 BIT PARALLEL INTERFACE
ALGEBRAIC CHECKSUM FOR EACH BLOCK
PERMANENT, PRE-RECORDED SECTOR ADDRESSES

2.2 TAPE

SCOTCH CAT. NO. 481-3/4-150-R42 (UNMARKED)
150 FEET LONG
3/4 INCH WIDE
10 TRACKS, 35 MIL, FULLY REDUNDANT
SANDWICH TAPE FOR LONG TAPE AND HEAD LIFE
3-13/16 INCH DIAMETER REEL
400 BPI PHASE RECORDING
16 BIT WORD
102,400 WORDS PER REEL (204,800 BYTES)
4200 WORDS/SECOND TRANSFER RATE (8400 BYTES/SECOND)
400 DATA BLOCKS
256 WORDS/BLOCK

2.3 PHYSICAL

8-3/4"H X 19"W X 12-3/16"D RACK MOUNT
2-1/8 FRONT PROJECTION
10-1/16 REAR PROJECTION (EXCLUDING PLUGS)
105-125 VOLTS, 60 HZ, 100 WATTS (50 HZ AVAILABLE)
35 POUNDS

2.4 MOUNTING

THE LINCTAPE IS DESIGNED FOR STANDARD RACK MOUNTING. THE DIMENSIONS ARE SHOWN IN FIGURE 2.1. IT IS ADVISABLE TO PROTECT THE HEADS, GUIDES, AND TAPE FROM DIRT AND DUST BY KEEPING THE FRONT DOOR CLOSED IN OPERATION. HOWEVER, IN A LABORATORY ENVIRONMENT, THE DOOR MAY BE REMOVED BY TWO SCREWS NEAR THE HINGE.

POWER, I/O, AND SLAVE CONNECTIONS ARE MADE IN THE REAR OF THE UNIT. ACCESS TO THE ELECTRONIC BOARDS IS MADE BY SWINGING THE REAR PANEL OR BY REMOVING THE REAR COVER OR THE TOP COVER.

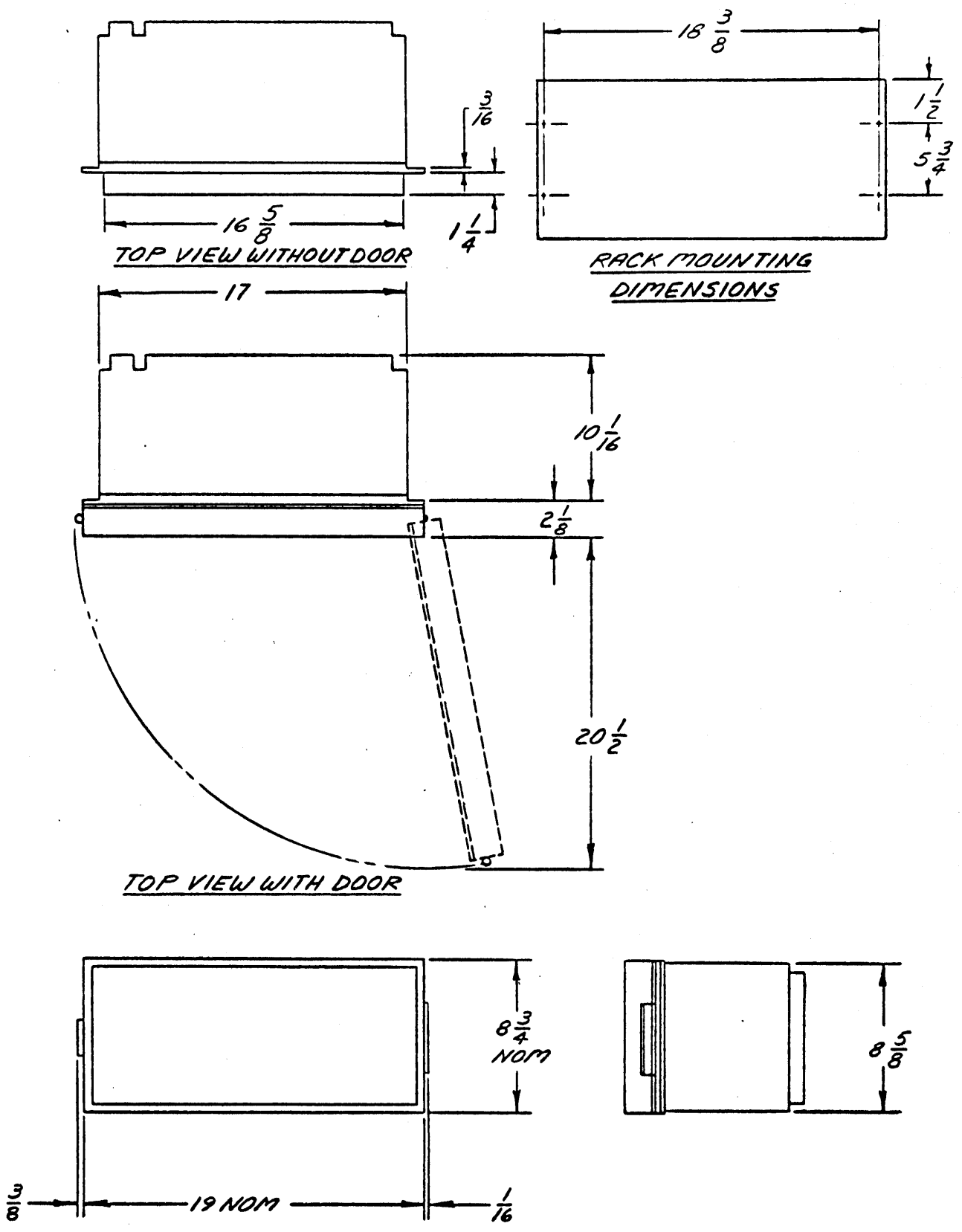


FIGURE 2.1
OUTLINE DIMENSIONS

2.5 PACKING LIST

CO-600-NP MASTER LINCTAPE UNIT
- 1 EA DUAL LINCTAPE DRIVE SYSTEM WITH READ/WRITE ELECTRONICS
- 1 EA LINE CORD
- 1 EA I/O CABLE
- 2 EA REELS OF MARKED LINCTAPE
- 1 EA INSTRUCTION BOOK

CO-605 SLAVE UNIT
- 1 EA DUAL LINCTAPE SLAVE DRIVE SYSTEM
- 1 EA LINE CORD
- 1 EA SLAVE ADAPTER CABLE
- 2 EA REELS OF MARKED TAPE
- 1 EA INSTRUCTION BOOK

NOTE: ADDITIONAL LINCTAPES, PRE-MARKED AND CERTIFIED, MAY BE OBTAINED FROM COMPUTER OPERATIONS, INC.

3.0 INSTALLATION

THE CPU MUST HAVE THE I/O CONNECTOR OPTION FOR PROPER INSTALLATION:

NOVA	DATA GENERAL TYPE	4022
SUPERNOVA	" "	8022
NOVA 800	" "	8222
NOVA 1200	" "	8122

STANDARD ON THE 1210, 1220, AND 820.

3.1 MOUNT THE LINCTAPE. IF THE LINCTAPE IS TO BE RACK MOUNTED:

A. REMOVE THE DOOR BY REMOVING THE TWO SCREWS HOLDING THE HINGE BLOCK TO THE FRONT PANEL. BE CAREFUL NOT TO SCRATCH THE HEADS OR THE GUIDES.

B. PLACE THE LINCTAPE IN POSITION AND FASTEN FIRMLY IN PLACE USING FOUR SCREWS THRU THE FLANGE SLOTS. IT IS ADVISABLE TO PROTECT THE FRONT PANEL FINISH BY USING A FIBER OR PLASTIC WASHER UNDER THE SCREW HEADS.

C. REPLACE THE DOOR, BEING SURE IT IS POSITIONED TO CLOSE PROPERLY.

3.2 CONNECT THE POWER CABLES. IF IT IS DESIRED TO HAVE THE COMPLETE SYSTEM TURN ON AND OFF WITH THE COMPUTER POWER SWITCH:

A. TURN OFF ALL POWER TO THE SYSTEM.

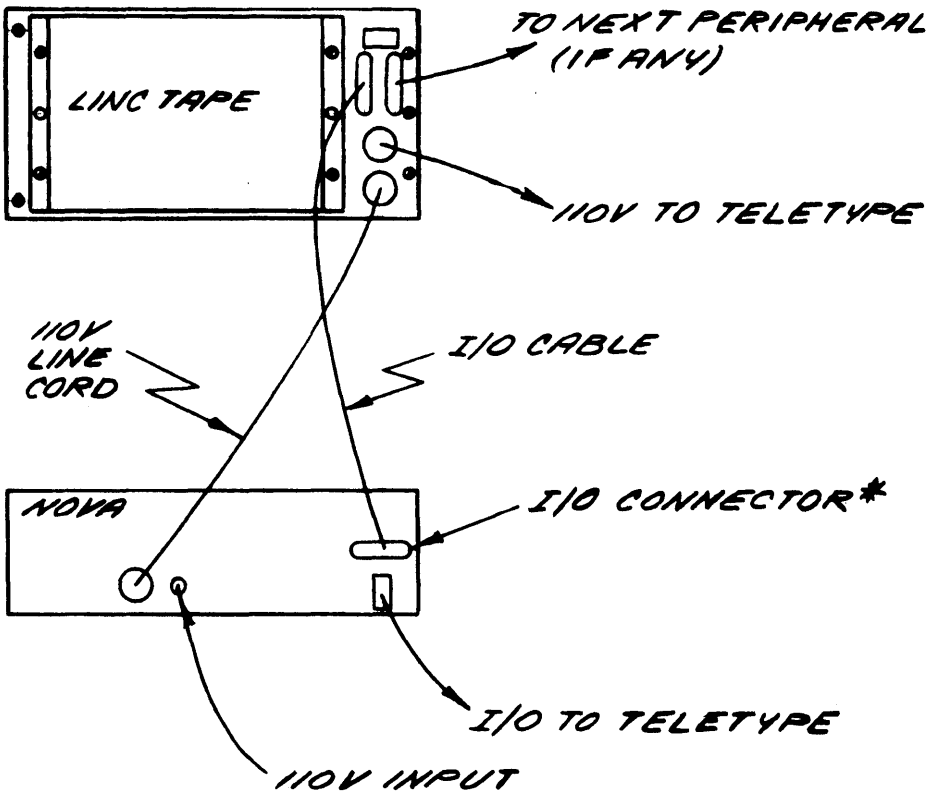
B. PLUG THE LINCTAPE POWER CABLE INTO THE OUTLET IN THE BACK OF THE COMPUTER.

C. PLUG THE NEXT PERIPHERAL DEVICE (SUCH AS THE TELETYPE) INTO THE OUTLET IN THE BACK OF THE LINCTAPE. REFER TO THE DATA GENERAL MANUAL TO DETERMINE THE PERMISSIBLE LOAD. LINCTAPE DRAWS ABOUT 1 AMP.

3.3 CONNECT THE I/O CABLES. THIS CONNECTION DEPENDS ON THE OTHER PERIPHERALS IN THE SYSTEM. ONE OF THE FOLLOWING CONNECTIONS SHOULD BE MADE:

A. IF THE LINCTAPE IS THE ONLY PERIPHERAL ON THE I/O CONNECTOR, SIMPLY CONNECT THE I/O CABLE (SUPPLIED WITH LINCTAPE) BETWEEN THE COMPUTER I/O CONNECTOR AND EITHER OF THE LINCTAPE I/O CONNECTORS. LEAVE THE REMAINING CONNECTOR ON THE LINCTAPE OPEN.

B. IF OTHER PERIPHERALS ARE TO BE CONNECTED ON THE SAME LINE, THEY CAN BE "DAISY CHAINED" BY USING BOTH CONNECTORS ON THE LINCTAPE. IN THIS CASE, CONNECT THE I/O CABLE BETWEEN THE COMPUTER AND LINCTAPE AS IN "A" ABOVE. THEN CONNECT THE NEXT PERIPHERAL CABLE TO THE REMAINING I/O CONNECTOR ON THE LINCTAPE. AT THE END OF THIS CHAIN, AN I/O TERMINATOR SHOULD BE USED. POWER FOR THE TERMINATOR MUST BE SUPPLIED BY THE LAST PERIPHERAL. SEE THE "HOW TO" MANUAL, REFERENCE 1, APPENDIX A.



* NOVA 1200 OPTION 8122
NOVA 800 OPTION 8222
SUPER NOVA OPTION 8022
NOVA OPTION 4022

FIGURE 3.1
CABLE DIAGRAM

3.4 SLAVE UNIT INSTALLATION. IF ONE OR MORE SLAVE UNITS ARE TO BE CONNECTED, THEY MAY BE STRUNG IN "DAISY CHAIN" FASHION. AS MANY AS SEVEN (7) SLAVES MAY BE SO CONNECTED, OR A TOTAL OF 16 DRIVES. SEE FIGURE 3.2.

THE TWO DRIVES ON THE MASTER UNIT ARE CONNECTED AS NUMBERS Ø AND 1. (EVEN NUMBERED DRIVES ARE ALWAYS ON THE LEFT AND ODD NUMBERED ONES ON THE RIGHT WHEN FACING THE FRONT.) SLAVE UNITS ARE NORMALLY WIRED TO BE NUMBERS 2 AND 3 AT THE FACTORY. IF ADDITIONAL SLAVES ARE ADDED, IT MAY BE NECESSARY TO CHANGE THE JUMPERS ON THE DRIVE CONTROL BOARD TO SUIT. IT IS IMPORTANT THAT NO TWO UNITS HAVE THE SAME DRIVE NUMBERS. SEE FIGURE 3.3.

TO CHANGE THE DRIVE NUMBER FOR ANY UNIT, THE FOLLOWING STEPS ARE REQUIRED:

1. DISCONNECT ALL POWER;
2. REMOVE THE 6 SCREWS ON THE TOP OF THE LINCTAPE AND REMOVE THE COVER;
3. DISCONNECT THE THREE EDGE CONNECTORS FROM THE TOP OF THE DRIVE CONTROL BOARD AND CAREFULLY REMOVE THE BOARD;
4. NOTE THE POSITION OF THE THREE JUMPER WIRES NEAR THE TOP CENTER OF THE BOARD. THEY ARE MARKED, AND THE SUM OF THE MARKINGS INDICATES THE DRIVE NUMBER OF THE LEFT HAND DRIVE. THE RIGHT DRIVE IS, OF COURSE, ONE NUMBER HIGHER. SEE FIGURE 3.3.
5. CAREFULLY UNSOLDER AND CHANGE THE NECESSARY JUMPERS TO SUIT. BE CAREFUL NOT TO DAMAGE THE PADS.
6. REPLACE THE BOARD, THE CONNECTORS, AND THE TOP COVER.

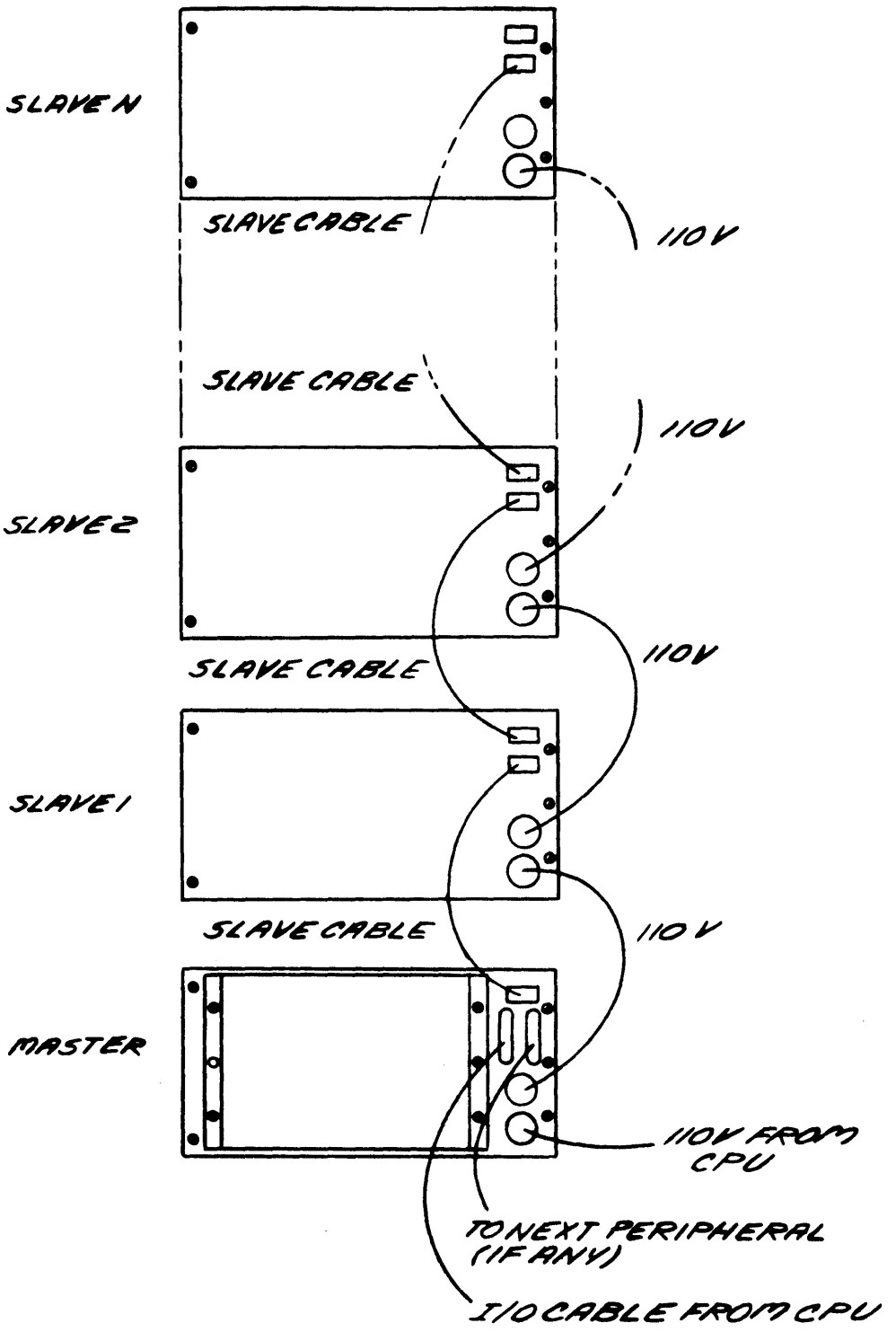
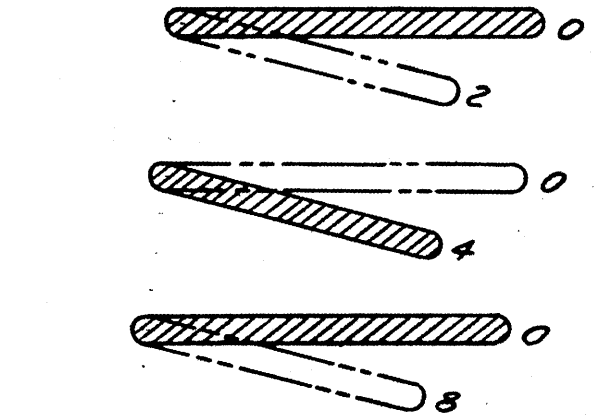


FIGURE 3.2
SLAVE CONNECTIONS



DRIVE NUMBERS 4 & 5 SHOWN

FIGURE 3.3
DRIVE NUMBER JUMPERS

4.0 LINCTAPE OPERATION

THE LINCTAPE SYSTEM HAS TWO DRIVES WHICH MAY BE OPERATED SEPARATELY. THE LEFT DRIVE IS NUMBERED Ø (ZERO) AND THE RIGHT DRIVE IS NUMBERED 1 (ONE). THE TAPE IS ALWAYS MOUNTED ON THE RIGHT (OR SOURCE) HUB OF EACH DRIVE. THE LEFT HUB HAS THE TAKEUP REEL WHICH SHOULD NOT BE REMOVED.

EACH DRIVE HAS THREE BUTTONS ASSOCIATED WITH IT: LOAD, REWIND, AND WRITE PROTECT. NEGLECTING WRITE PROTECT, THERE ARE FOUR MODES OF OPERATION POSSIBLE FOR EACH DRIVE: OFF, FORWARD, REVERSE, AND TENSION. WHEN POWER IS FIRST APPLIED, BOTH DRIVES WILL BE IN THE OFF MODE.

THE LOAD (OR LEFT) BUTTON IS THE WHITE MOMENTARY CONTACT BUTTON ON THE LEFT SIDE OF EACH DRIVE. IT WILL MOVE THE TAPE FORWARD. WHEN RELEASED, THE DRIVE WILL BE IN THE TENSION MODE. THE DRIVE MUST BE IN THE TENSION MODE BEFORE THE COMPUTER CAN ACCESS IT. THE OPERATOR SHOULD CHECK THE TENSION IF THE LINCTAPE FAILS TO RESPOND TO COMPUTER COMMANDS.

THE REWIND (OR RIGHT) BUTTON IS THE WHITE MOMENTARY CONTACT BUTTON ON THE RIGHT SIDE OF EACH DRIVE. IT WILL MOVE THE TAPE IN THE REVERSE DIRECTION. WHEN RELEASED, THE DRIVE WILL BE IN THE OFF MODE.

THE WRITE PROTECT BUTTON IS THE RED ALTERNATE ACTION BUTTON LOCATED UNDER EACH HEAD. WHEN IT IS LIGHTED, IT IS IMPOSSIBLE FOR THE COMPUTER TO WRITE ON THE TAPE, AND THE DRIVE IS THUS PROTECTED FROM ACCIDENTAL WRITING. THE BUTTON HAS NO EFFECT ON READING.

TO MOUNT A TAPE ON EITHER DRIVE, PRESS THE REEL FIRMLY OVER THE HUB UNTIL IT SNAPS INTO PLACE. PASS THE END OF THE TAPE OVER THE GUIDES AND HEAD AND LAY IT ON THE TAKEUP REEL. HOLD THE TAPE AGAINST THE TAKEUP REEL AND WIND IT ON A COUPLE OF TURNS. TURN THE REELS TO TAKE UP ANY SLACK, AND PRESS THE LOAD BUTTON BRIEFLY. THE REELS SHOULD STOP WITH THE TAPE IN TENSION.

TO UNLOAD A TAPE, HOLD THE REWIND (OR RIGHT) BUTTON UNTIL THE TAPE UNWINDS. PULL THE REEL OFF BY PRESSING AGAINST THE HUB AND PULLING ON THE REEL UNTIL THE REEL SNAPS OFF.

CAUTION: CERTAIN PRECAUTIONS SHOULD BE OBSERVED CONCERNING ANY MAGNETIC TAPE SYSTEM, LINCTAPE INCLUDED:

(1) BE CAREFUL OF THE HEADS AND GUIDES. DO NOT SCRATCH THEM;

(2) KEEP THE TAPES, HEADS, AND GUIDES CLEAN. SEE SECTION 13;

(3) KEEP TAPES AWAY FROM STRONG MAGNETIC FIELDS, SUCH AS MIGHT BE FOUND NEAR TRANSFORMERS, MOTORS, FLUORESCENT LIGHT BALLASTS, ETC.

(4) DO NOT USE STICKY TAPE, SUCH AS "SCOTCH" TAPE OR ADHESIVE LABELS, ON THE TAPE. IN TIME, THE STICKY MATERIAL TENDS TO SEEP OUT, AND DISTRIBUTE ITSELF OVER THE TAPE AND GUIDES, CAUSING DROPOUTS. TO IDENTIFY A TAPE, PUT LABELS ON THE REEL.

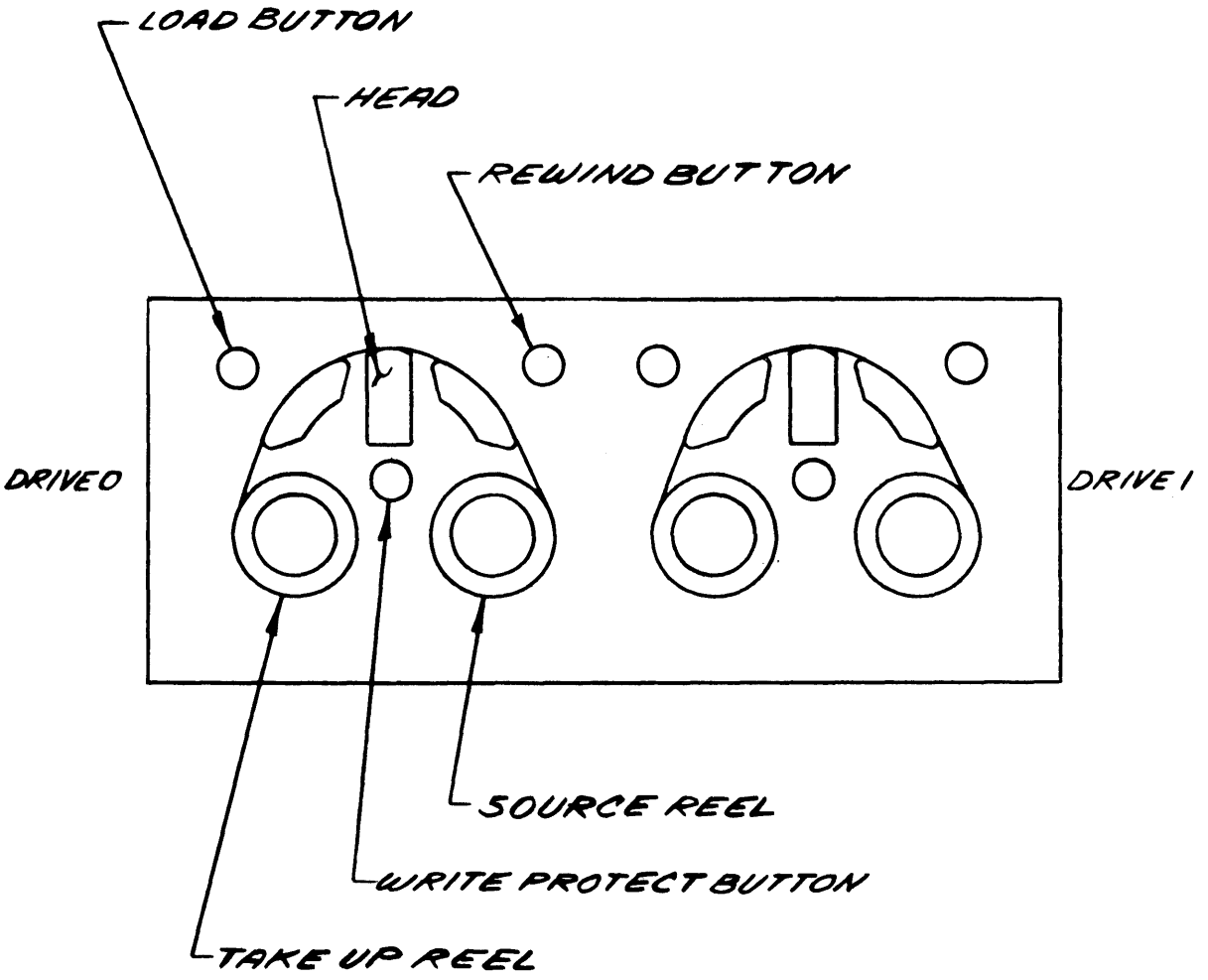


FIGURE 4.1
FRONT PANEL CONTROLS

5.0 BOOTSTRAP

THE LINCTAPE BOOTSTRAP CAN BE USED WITH ANY OF THE NOVA SERIES COMPUTERS. IT ALLOWS QUICK AND EASY LOADING OF PROGRAMS FROM LINCTAPE.

THERE ARE TWO DIFFERENT PROCEDURES, DEPENDING ON WHETHER THE COMPUTER HAS A HARDWARE PROGRAM LOADER OR NOT.

THE PROCEDURE FOR THESE BOOTSTRAPS ARE DESCRIBED IN DETAIL IN APPENDIX A.

6.0 KEYBOARD EXECUTIVE ROUTINE.

THE KEYBOARD EXECUTIVE ROUTINE IS DESIGNED TO TRANSFER DATA AND PROGRAMS BETWEEN CORE AND LINCTAPE VIA THE KEYBOARD WITH A MINIMUM OF OPERATOR EFFORT. IT HAS TWO MODES OF OPERATION: GENERAL AND AUTOMATIC.

6.1 GENERAL MODE.

THE GENERAL MODE ALLOWS ANY NUMBER OF CONTIGUOUS BLOCKS OF DATA OR INFORMATION TO BE READ FROM OR WRITTEN ONTO LINCTAPE. THE FORMAT, WHICH REQUIRES 5 PARAMETERS, IS:

```
*1000,10,4,0R
   WHERE      *   IS THE RESPONSE GIVEN BY THE KEYBOARD
                  EXEC WHEN WAITING FOR AN OPERATOR INPUT
           1000   IS THE FIRST CORE LOCATION
             10   IS THE FIRST BLOCK NUMBER
              4   IS THE NUMBER OF BLOCKS
              0   IS THE DRIVE NUMBER
              R   MEANS READ FROM TAPE INTO CORE.
```

THIS STRING, WHEN TYPED INTO THE KEYBOARD EXEC, WILL READ THE CONTENTS OF BLOCKS 10 THRU 13 FROM THE TAPE ON DRIVE 0 INTO CORE LOCATIONS 1000 THRU 2777. (NOTE THAT ALL NUMBERS ARE IN OCTAL.) COMMAS ARE USED TO SEPARATE THE PARAMETERS, EXCEPT NO SEPARATOR IS NEEDED BETWEEN THE DRIVE NUMBER AND THE COMMAND LETTER.

READ (R) MEANS TO TRANSFER BLOCKS OF DATA FROM LINCTAPE AND STORE THEM IN CORE. PREVIOUS DATA IN THE SPECIFIED AREAS OF CORE ARE, OF COURSE, LOST. THE DATA ON TAPE IS NOT ALTERED.

WRITE (W) MEANS TO TRANSFER BLOCKS OF INFORMATION FROM CORE AND WRITE THEM ON LINCTAPE. PREVIOUS DATA IN THE SPECIFIED BLOCKS OF TAPE ARE LOST, BUT CORE IS NOT ALTERED. AFTER WRITING, THE TAPE IS CHECKED ON A SECOND PASS.

CHECK (C) DOES NOT TRANSFER INFORMATION, BUT IT DOES CHECK AREAS OF TAPE FOR PROPER CHECKSUMS. IT IS PRIMARILY USED FOR TESTING PURPOSES.

THE KEYBOARD EXEC REQUIRES THE UTILITY SUBROUTINES TO BE IN CORE. NORMALLY, BOTH ARE RESIDENT. TO RE-ENTER THE KEYBOARD EXEC AT ANY TIME, START THE COMPUTER AT THE ENTRY LOCATION X7000 (X7777 IS THE HIGHEST CORE LOCATION).

PRECAUTIONS AND LIMITATIONS

1. THERE ARE THREE COMMANDS: READ(R), WRITE(W), AND CHECK(C);
2. ALL PARAMETERS MUST BE IN OCTAL;
3. EACH BLOCK CONTAINS 400 (256 DECIMAL) WORDS. WHOLE BLOCKS ARE ALWAYS TRANSFERRED.
4. NEGATIVE NUMBERS MUST BE ENTERED AS TWOS COMPLEMENT NUMBERS:
   177776 = -2
5. BLOCK NUMBERS BELOW -6 (177772) ARE NOT ACCEPTABLE TO THE KEYBOARD EXEC, NOR ARE BLOCKS ABOVE 617 (OCTAL);
6. OVERFLOW BITS ARE IGNORED. THAT IS, ONLY THE LOWER 16 BITS OF THE TYPED NUMBER ARE USED:
   77777776 = 177776 = -2
7. NUMBERS NOT TYPED ARE ASSUMED TO BE ZERO:
   1000,,2,R MEANS CORE LOC 1000, STARTING BLOCK ZERO
   2 BLOCKS, DRIVE 0, READ.
8. IT IS THE OPERATORS RESPONSIBILITY NOT TO READ OVER THE KEYBOARD EXEC OR THE UTILITIES. THESE RESIDE IN LOCATIONS X7000 THRU X7377 AND X7400 THRU X7777 RESPECTIVELY.

6.2 AUTOMATIC MODE

CLEARLY, IN THE GENERAL MODE, IT IS NECESSARY THAT THE OPERATOR KNOW WHERE PARTICULAR PROGRAMS OR DATA ARE STORED ON TAPE. THE AUTOMATIC MODE ALLOWS FREQUENTLY USED PROGRAMS TO BE READ (BUT NOT WRITTEN) QUICKLY, WITHOUT THE NEED TO KNOW EXACTLY WHERE THEY ARE STORED ON TAPE. FOR INSTANCE, TYPING "A" INTO THE KEYBOARD EXEC COULD LOAD THE ASSEMBLER.

EACH TYPE OF TAPE (SYSTEM, PROGRAM, ETC.) MAY HAVE DIFFERENT PROGRAMS, EACH WITH ITS OWN CODE LETTERS. THE CORE LOCATION AND BLOCK NUMBERS ARE STORED IN A TABLE IN THE KEYBOARD EXEC. THE PROPER TAPE MUST BE ON DRIVE Ø WHEN USING THE AUTOMATIC MODE. THIS AUTOMATIC MODE WILL LOAD, BUT WILL NOT EXECUTE THE CALLED PROGRAM. THE OPERATOR MUST DO THIS SEPARATELY. THIS ALLOWS SEVERAL PROGRAMS TO BE LOADED AT ONE TIME AND EXECUTED SELECTIVELY.

THE COMMAND LETTERS AND THEIR ASSOCIATED PARAMETERS MAY BE MODIFIED AS PROGRAMS ARE ADDED OR DELETED FROM THE TAPE. SEE THE EXEC LISTING FOR DETAILS.

LINCTAPES, WHEN SUPPLIED BY COI, NORMALLY CONTAIN NO PROGRAMS ON TAPE OTHER THAN THE BOOTSTRAP, UTILITIES, AND KEYBOARD EXEC. THE AUTOMATIC MODE TABLE IS EMPTY.

6.3 COMPUTER RESPONSE.

AFTER THE TRANSFER TAKES PLACE, THE TELETYPE WILL RESPOND WITH ANOTHER "*", INDICATING THAT THE PREVIOUS COMMAND WAS EXECUTED, AND THE EXEC IS WAITING FOR ANOTHER OPERATOR COMMAND.

IF AN ERROR OCCURS, THE TELETYPE WILL PRINT A "?" AND THEN THE "*". THE POSSIBLE ERRORS THAT MAY OCCUR INCLUDE:

1. DRIVE NOT READY (NOT IN TENSION MODE),
2. A WRITE ATTEMPT WAS MADE ON A PROTECTED DRIVE,
3. THE COMMAND LETTER, EITHER GENERAL OR AUTOMATIC, IS NOT VALID,
4. A NON-OCTAL NUMBER WAS TYPED,
5. A NON VALID CHARACTER (SUCH AS SPACE) WAS TYPED,
6. A NON-VALID BLOCK WAS REQUESTED (VALID BLOCKS ARE 177772 THRU 617, INCLUSIVE),
7. THE TAPE IS BAD, CONTAINING ERRONEOUS CHECKSUM, BLOCK NUMBER, ETC.

7.0 LINCTAPE UTILITIES

THE LINCTAPE UTILITY SUBROUTINES ARE A SET OF SOFTWARE WHICH MAKE IT EASY FOR THE PROGRAMMER TO COMMUNICATE WITH THE LINCTAPE. THEY ALLOW READING AND WRITING WITH A FEW SIMPLE INSTRUCTIONS, AND RELIEVE THE PROGRAMMER OF THE DETAILS OF TIMING, BLOCK SEARCHING, ETC. ONLY DRIVE SELECTION IS LEFT UP TO THE PROGRAMMER.

NORMALLY, THE UTILITIES ARE LOADED NEAR THE TOP OF CORE, AND ARE NEVER CHANGED (THEY ARE SAID TO BE RESIDENT). THEY OCCUPY LOCATIONS X7400-X7577 (X7777 IS THE LAST LOCATION IN CORE). ALL CALLS MUST BE MADE WITH A 'JSR@' STATEMENT TO ONE OF THE FOLLOWING ENTRY POINTS:

CLINC	X7400	CHECK BLOCKS
RLINC	X7403	READ & CHECK BLOCKS
WLINC	X7406	WRITE & CHECK BLOCKS

WITH THE REGISTERS LOADED AS FOLLOWS:

- AC0 = FIRST BLOCK NUMBER TO BE PROCESSED,
- AC1 = NUMBER OF BLOCKS TO BE PROCESSED, AND
- AC2 = FIRST CORE LOCATION.

IF AC1 = 0, THE TAPE WILL PRE-POSITION ITSELF NEAR THE BLOCK NUMBER SPECIFIED IN AC0.
IF AC2 IS NEGATIVE, THE DRIVE WILL START BACKWARD (THUS SAVING TIME IS IT IS KNOWN THAT THE BLOCK TO BE FOUND HAS BEEN PASSED), AND IT WILL TAKE THE 1'S COMPLEMENT (NOT THE NEGATIVE) OF THE NUMBER IN AC2 AS THE FIRST CORE LOCATION.

THE UTILITIES WILL RETURN TO THE PROGRAM WITH THE DRIVE STOPPED, AND THE REGISTERS CONTAINING THE FOLLOWING INFORMATION:

- AC1 = 0 FOR NORMAL (NON-ERROR) RETURN
- AC2 = NEXT BLOCK NUMBER
- AC3 = NEXT CORE LOCATION

IF THERE IS AN ERROR, AC1 CONTAINS THE ERROR CODE:

- AC1 = 1 IF THERE WAS A CHECKSUM ERROR:
  - AC0 = BAD BLOCK NUMBER
- AC1 = 2 IF THERE WAS A BLOCK SIZE ERROR:
  - AC0 = BAD BLOCK NUMBER
  - AC2 = EXCESS OF WORDS IN BLOCK
  - AC3 = EXPECTED NUMBER OF WORDS
- AC1 = 4 IF THERE WAS AN ILLEGAL BLOCK CALLED FOR (-6 THRU 617 ARE LEGAL NORMALLY):
  - AC0 = TARGET BLOCK
  - AC2 = NEXT CORE LOCATION
  - AC3 = HIGHEST LEGAL BLOCK
- AC1 = 8 IF THERE WAS A DRIVE STATUS ERROR:
  - AC3 = DRIVE STATUS
    - BIT 15 ON = DRIVE NOT READY (TENSION)
    - BIT 14 ON = WRITE ATTEMPTED ON PROTECTED DRIVE

THE CALLING SEQUENCE IS (ASSUMING .RDX = 8):

```
    LINC    =74                 ;LINCTAPE DEVICE NUMBER

            LDA     0,DRVNO
            DOB     0,LINC      ;SELECT DRIVE NUMBER
            ---
            LDA     0,FBLKN     ;SET AC0 = 1ST BLOCK NO
            LDA     1,NBLKS     ;SET AC1 = NO OF BLOCKS
            LDA     2,FCORE     ;SET AC2 = 1ST CORE LOC
            JSR@    RLINC       ;READ THE BLOCKS
            MOV     1,1,SZR     ;TEST FOR ERROR
            ---
            ---
    WLINC:  X7406               ;WRITE POINTER
    RLINC:  X7403               ;READ POINTER
    FBLKN:  100
    NBLKS:  10
    FCORE:  1000
    DRVNO:  1
```

THE ABOVE WILL READ THE CONTENTS OF BLOCK NUMBERS 100 THRU 107 FROM THE TAPE ON DRIVE 1 INTO CORE LOCATIONS 1000 THRU 4777 (ALL IN OCTAL, AND ASSUMING STANDARD 400 WORD BLOCKS).

8.Ø LINCTAPE I/O INSTRUCTIONS

USUALLY, THE STANDARD LINCTAPE UTILITIES WILL HANDLE ALL NECESSARY COMMUNICATION BETWEEN THE LINCTAPE AND THE COMPUTER. IT IS RECOMMENDED THAT, WHENEVER POSSIBLE, THESE BE USED.

HOWEVER, IN THOSE CASES WHERE THEY ARE INADEQUATE, OR WHERE SPECIAL CONDITIONS REQUIRE CHANGES, THE ACTUAL I/O COMMANDS AND LIMITATIONS ARE GIVEN IN THIS SECTION.

THE LINCTAPE IS A PERIPHERAL DEVICE, WHICH IS ADDRESSED IN THE SAME MANNER AS ALL OTHER PERIPHERALS, THRU THE I/O COMMANDS. REFER TO THE "HOW TO USE" MANUAL, REFERENCE 1. THE COMMANDS NECESSARY FOR OPERATION OF THE LINCTAPE INCLUDE THE FOLLOWING:

- DRIVE COMMANDS
  - SELECT DRIVE NUMBER
  - START DRIVE FORWARD
  - START DRIVE BACKWARD
  - STOP DRIVE
- STATUS
  - DRIVE READY
  - WRITE PROTECT
  - BLOCK NUMBER READY
  - DATA WORD READY
  - CHECKSUM READY
- DATA TRANSFER
  - INPUT DATA WORD
  - OUTPUT DATA WORD
  - TURN WRITERS ON

SPECIFICALLY, THE FOLLOWING INSTRUCTIONS ARE APPLICABLE:

LINC = DEVICE NUMBER 74 (OCTAL) NORMALLY

DATA I/O.

DIA	X,LINC	INPUT THE 16 BIT DATA WORD TO ACX.
DOA	X,LINC	OUTPUT THE 16 BIT WORD IN ACX TO THE LINCTAPE.
DIB	X,LINC	INPUT THE STATUS BITS TO ACX BIT 15 ON = NOT READY BIT 14 ON = WRITE PROTECTED
DOB	X,LINC	SELECT DRIVE NUMBER. THE DRIVE NUMBER MUST BE IN THE 4 LOW ORDER BITS OF ACX.
DOC	X,LINC	TURN WRITER ON. THE WRITERS ARE AUTOMATICALLY TURNED OFF AT THE END OF EACH BLOCK. THE VALUE OF X IS ARBITRARY. ANY ACX MAY BE USED.

CONTROL PULSES. THESE MAY BE COMBINED WITH ANY OF THE I/O COMMANDS IN THE USUAL MANNER:

S	START THE SELECTED DRIVE FORWARD;
P	START THE SELECTED DRIVE BACKWARD;
C	STOP THE DRIVE. THE DRIVE DOES NOT STOP AUTOMATICALLY AT THE END OF A BLOCK. THIS ALLOWS RAPID TRANSFER OF SUCCESSIVE BLOCKS, BUT IT MEANS THE PROGRAM MUST STOP THE DRIVE. IT SHOULD NOT BE STOPPED UNTIL THE NEXT BLOCK NUMBER IS READY, ESPECIALLY ON WRITING.

SKIP LINES. THERE ARE FOUR POSSIBLE CONDITIONS: (1) BLOCK NUMBER READY, (2) DATA READY, (3) CHECKSUM READY, OR (4) NONE OF THEM READY.

```
SKPDN LINC  SKIP IF DATA OR CHECKSUM IS READY;
SKPDZ LINC  SKIP IF BLOCK OR NONE IS READY;
SKPBN LINC  SKIP IF BLOCK NUMBER OR CHECKSUM IS READY;
SKPBZ LINC  SKIP IF DATA OR NONE READY.
```

NOTE THAT IT REQUIRES TWO SKIP COMMANDS TO DETERMINE WHETHER A SPECIFIC TYPE OF WORD IS READY. NOTE ALSO THAT ALL COMMANDS EXCEPT DRIVE SELECT, APPLY TO THE SELECTED DRIVE ONLY.

SPECIAL

```
IORST  STOP DRIVE AND SELECT DRIVE 0;
FRONT PANEL RESET IS THE SAME AS IORST.
```

FOR EXAMPLES OF THIS PROGRAMMING, REFER TO THE LISTINGS OF THE LINCTAPE UTILITIES.

TIMING

IN MOST CASES, TIMING IS NOT CRUCIAL. OCCASSIONALLY, HOWEVER IT IS IMPORTANT THAT THE PROGRAMMER KNOW SOME OF THE BASIC TIMES INVOLVED. THE FOLLOWING ARE APPROXIMATE, AND MAY VARY BY 10 % IN THE FORWARD DIRECTION AND 30 % IN THE REVERSE DIRECTION. SEE THE DIAGRAM IN FIGURE 10.2.

TAPE END TO END	25 SECONDS
START/TURN AROUND TIME	130 MILLISECONDS
BLOCK TO BLOCK	63 MILLISECONDS (256 WORD BLOCKS)
WORD TO WORD	240 MICROSECONDS
READY (BLOCK,DATA,CKSM)	40 MICROSECONDS (RESET BY DATA TRANSFER). MUST INPUT OR OUTPUT THE WORD DURING THIS TIME.

IN GENERAL, THE FOLLOWING RULES SHOULD BE OBSERVED:

1. DRIVE SELECTION SHOULD PRECEDE ANY MOTION;
2. DRIVE SELECTION SHOULD BE FOLLOWED BY A STATUS CHECK TO SEE IF (1) THE DRIVE IS READY AND (2) IT IS NOT PROTECTED WHEN WRITING;
3. DRIVE MAY BE STARTED FORWARD OR BACKWARD;
4. AN ACCELERATION DELAY OF 130 MS ALWAYS OCCURS WHEN STARTING OR CHANGING DIRECTION;
5. MARKS ARE TRUE FOR 36 TO 44 US FORWARD, AND 30 TO 50 US WHEN MOVING BACKWARD;
6. "BUSY" AND "DONE" ARE ENCODED FOR MARK SENSING. THEY ARE RESET WHENEVER A DIA OR DOA COMMAND IS SENT, SO A MARK CANNOT BE DOUBLY DETECTED.
7. FOLLOWING DETECTION OF ANY MARK IN A SKIP LOOP, A DIA OR DOA MUST BE ISSUED TO CLEAR THE DONE AND BUSY LINE, EVEN IF THE MARK WAS NOT THE TYPE DESIRED.
8. MOTION COMMANDS MAY BE REPEATED WHILE MOVING WITHOUT CAUSING ACCELERATION DELAY. MOTION MAY BE REVERSED WITHOUT STOPPING.
9. "WRITERS ON" COMMAND MUST NEVER BE GIVEN WHILE THE DRIVE IS GOING BACKWARD;
10. "WRITERS ON" COMMAND MUST BE GIVEN AFTER THE BLOCK MARK IS SENSED, BUT BEFORE THE FIRST DATA MARK COMES TRUE. THIS IS 220 US NOMINALLY.
11. AFTER A WRITE, MOTION MAY NOT BE CHANGED OR STOPPED UNTIL THE NEXT BLOCK MARK IS DETECTED. IN GENERAL, MOTION DECISIONS SHOULD BE MADE ONLY ON BLOCK MARKS.
12. SHOULD THE DRIVE STATUS CHANGE TO "NOT READY" DURING THE PROGRAM OPERATION, TAPE MOTION IS CLEARED AND MARKS CANNOT BE DETECTED UNTIL THE DRIVE IS RE-TENSIONED AND FORWARD OR START BACKWARD COMMAND IS GIVEN;

9.0 LINCTAPE FORMAT

TO UNDERSTAND THE OPERATION OF THE LINCTAPE, IT IS NECESSARY TO VISUALIZE THE FORMAT ON THE TAPE. THIS SECTION DESCRIBES THE LINCTAPE ITSELF.

9.1 PHYSICAL DESCRIPTION

THE TAPE IS 150 FEET LONG, AND 3/4 INCH WIDE. IT IS ABOUT 0.0015 INCHES THICK, AND THE OXIDE IS SANDWICHED BETWEEN TWO LAYERS OF MYLAR.

THE TAPE IS DIVIDED, BY ITS PRE-WRITTEN MARKINGS, INTO THREE SECTIONS: FRONT LEADER, DATA BLOCKS, AND TRAILER. SEE FIGURE 9.1.

9.2 FRONT LEADER

THE FRONT LEADER HAS THREE PARTS: BLANK AREA, END ZONE, AND PRELIMINARY BLOCKS

9.2.1 BLANK AREA

THIS IS A SMALL AREA AT THE BEGINNING OF THE TAPE WHICH HAS NO MARKS OF ANY KIND. IT IS ABOUT TWO FEET LONG.

9.2.2 END ZONE

THE END MARKS AT THE FRONT OF THE TAPE ARE USED TO ASSURE THAT THE TAPE, ONCE UP TO SPEED, HAS SYNCHRONIZING INFORMATION. IT IS ESSENTIAL, WHEN BOOTSTRAPPING, THAT THE TAPE BE STARTED IN THIS AREA SO THAT THE FIRST BLOCK WILL BE PROPERLY LOADED. THUS THIS END ZONE MUST BE LONG ENOUGH THAT THE OPERATOR WILL NOT EASILY OVERSHOOT IT WHEN MANUALLY LOADING. A VISUAL MARKER ON THE TAPE HELPS TO ASSURE THIS. THIS END ZONE IS SEVERAL FEET LONG.

9.2.3 PRELIMINARY BLOCKS

THE FIRST FEW BLOCKS ARE USED FOR BOOTSTRAPPING AND FOR STORING SPECIAL PROGRAMS. THEY ARE GIVEN NEGATIVE BLOCK NUMBERS, SO THE PROGRAMMER CAN NORMALLY USE ALL POSITIVE BLOCKS WITHOUT DESTROYING THIS AREA. STANDARD TAPES HAVE 8 SUCH BLOCKS, NUMBERED -8 THRU -1. OTHERWISE, THESE BLOCKS ARE IDENTICAL TO DATA BLOCKS.

9.3 DATA BLOCKS

THE MAIN DATA ON TAPE IS CONTAINED IN 400 ADDRESSABLE BLOCKS, EACH CONTAINING 256 (400 OCTAL) 16 BIT WORDS. EACH BLOCK ALSO CONTAINS ITS CHECKSUM, ITS OWN BLOCK NUMBER, AND OTHER HOUSEKEEPING INFORMATION. EACH BLOCK IS ABOUT 4 INCHES LONG.

9.3.1 BLOCK NUMBERS

THERE ARE TWO BLOCK NUMBERS FOR EACH BLOCK. ONE IS AT THE BEGINNING OF EACH BLOCK AND CAN BE READ IN THE FORWARD DIRECTION. THE OTHER IS AT THE END OF EACH BLOCK AND CAN BE READ ONLY IN THE REVERSE DIRECTION.

9.3.2 DATA WORD

EACH 16 BIT DATA WORD OCCUPIES SIX LONGITUDINAL CHARACTERS ON TAPE. THERE ARE THREE DATA TRACKS AND ONE MARK TRACK. THIS ALLOWS FOR 18 DATA BITS, OF WHICH ONLY 16 ARE USED, AND FOR SIX MARK BITS.

9.3.3 CHECKSUM
THIS IS THE SUM, MODULO 65,536 (2**16), OF ALL WORDS IN A GIVEN BLOCK. IT IS OBTAINED BY SIMPLY ADDING EACH WORD IN THE COMPUTER AND IGNORING ANY OVERFLOW. THIS WORD IS WRITTEN ON THE TAPE IMMEDIATELY FOLLOWING THE LAST DATA WORD IN EACH BLOCK.

9.4 TRAILER
THE TRAILER, LIKE THE LEADER, HAS THREE ZONES: FINAL BLOCKS, END ZONE, AND BLANK TAPE.

9.4.1 FINAL BLOCKS
THE FINAL BLOCKS, NUMBERED 620 THRU 627 ARE NECESSARY FOR TURN-AROUND SPACE. SINCE THE TAPE "COASTS" ONE OR TWO BLOCKS PAST THE LAST BLOCK ADDRESSED, AND SINCE THE TAPE USUALLY STARTS IN THE FORWARD DIRECTION TO LOCATE ITS POSITION, SEVERAL INCHES OF IDENTIFIED SPACE IS NEEDED AFTER THE LAST USABLE BLOCK.

9.4.2 END ZONE
THIS IS USED FOR IDENTIFICATION WHEN MARKING TAPES, AND IS NOT NORMALLY USED BY THE PROGRAMMER.

9.4.3 BLANK ZONE
THIS IS THE END OF THE TAPE WITH NO MARKS.

9.5 TRACKS
THERE ARE 10 TRACKS: ONE TIMING, ONE MARK, THREE DATA, AND THESE SAME TRACKS REPEATED (REDUNDANT).

9.5.1 TIMING
THE TIMING TRACKS CONTAIN A SYNCHRONIZING SQUARE WAVE WHICH IS USED TO CLOCK THE REST OF THE SYSTEM.

9.5.2 MARK
THE MARK TRACKS CONTAIN A UNIQUE SET OF CODES WHICH IS USED TO IDENTIFIY THE INFORMATION ON THE CORRESPONDING DATA TRACKS.

9.5.3 DATA TRACKS
THE THREE SETS OF DATA TRACKS CONTAIN THE LOW, MEDIUM, AND HIGH ORDER SIX BITS OF INFORMATION (THE TWO HIGH ORDER BITS ARE NOT USED).

9.5.4 BIT PLACEMENT
FIGURE 9.1 SHOWS THE ARRANGEMENT OF BITS ON THE TAPE. IT ILLUSTRATES THE TRACK REDUNDANCY AND THE RELATIONSHIP OF THE MARK TRACK.

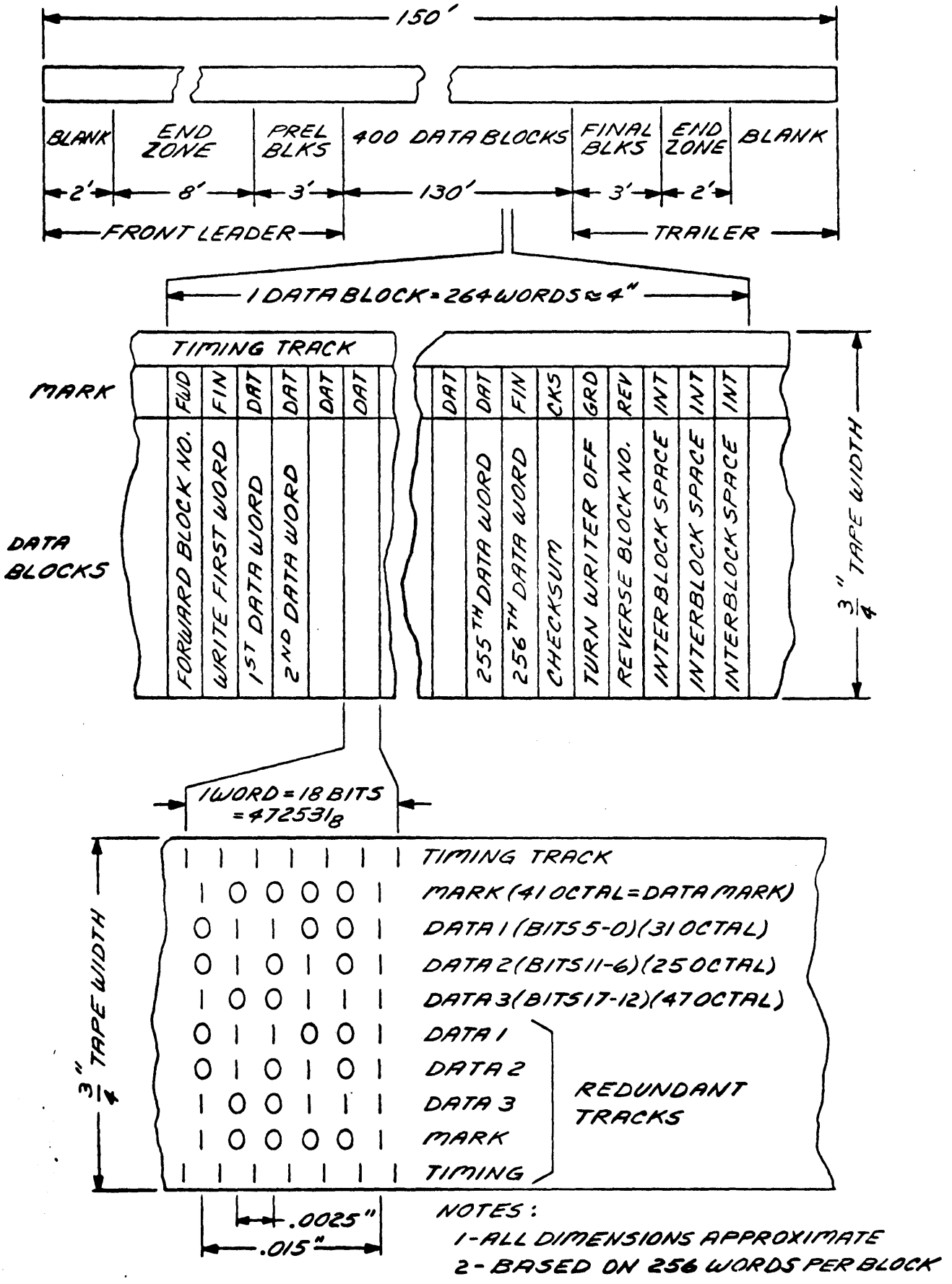


FIGURE 9.1
LINC TAPE FORMAT

10.0 THEORY OF OPERATION

LINCTAPE, UNLIKE INDUSTRY COMPATIBLE TAPE, DOES NOT HAVE TO STOP SUDDENLY IN A PARTICULAR RECORD GAP. SINCE LINCTAPE HAS CODED MARKS ON THE TAPE ITSELF, IT IS ALWAYS POSSIBLE TO KNOW EXACTLY WHERE ON THE TAPE THE DATA IS BEING READ OF WRITTEN. THIS LEADS TO SEVERAL ADVANTAGES:

THE DRIVE SYSTEM IS SIMPLE WITH VERY FEW MOVING PARTS;
THE TAPE ACCELERATION CAN BE SLOWER, THUS HANDLING THE TAPE MORE GENTLY;
THE COMPUTER DOES NOT NEED TO KEEP TRACK OF THE TAPE POSITION, SINCE THIS CAN BE FOUND ON THE TAPE ITSELF;
DATA CAN BE WRITTEN OVER OLD DATA PRECISELY, WITHOUT DANGER OF UNDER- OR OVER-WRITING ADJACENT RECORDS;
BLOCK SEARCHING CAN BE DONE IN EITHER DIRECTION.

THE LINCTAPE SYSTEM CONSISTS OF MAGNETIC TAPE WITH FIVE EFFECTIVE TRACKS. FIGURE 10.1 SHOWS THE BASIC BLOCK DIAGRAM, AND FIGURE 9.1 ILLUSTRATES THE TAPE PATTERNS.

THE TIMING TRACK IS USED TO SYNCHRONIZE THE INFORMATION FROM ALL OTHER TRACKS. IT IS A SIMPLE SQUARE WAVE, 90 DEGREES OUT OF PHASE FROM THE OTHER TRACKS. THIS ALLOWS THE EDGES OF THE TIMING SIGNAL TO STROBE ALL OTHER DATA.

THE MARK TRACK IS THE KEY TO THE LINCTAPE SYSTEM. IT IS A SERIES OF UNIQUE, SIX BIT CODES WHICH IDENTIFY THE INFORMATION IN THE CORRESPONDING DATA TRACKS. THESE CODES SPECIFY WHEN THE DATA, CHECKSUM, OR BLOCK NUMBERS ARE AVAILABLE IN THE DATA REGISTERS.

THE THREE DATA TRACKS CONTAIN 6 BITS OF DATA PER TRACK FOR A TOTAL OF 18 BITS. TWO BITS ARE UNUSED. THESE TRACKS ALSO CONTAIN THE CHECKSUM (FOLLOWING THE LAST DATA WORD), AND THE FORWARD AND REVERSE BLOCK NUMBERS, AT THE BEGINNING AND END OF EACH BLOCK, RESPECTIVELY.

AS THE TAPE MOVES WHILE READING, THE BITS FROM TAPE ARE SHIFTED SERIALLY INTO THE FOUR SHIFT REGISTERS AT A 25 KHZ RATE. WHEN THE PATTERN IN THE MARK REGISTER IS 41(OCTAL), THE MARK DECODING CIRCUITRY SETS THE "DATA READY" LINE. DURING THIS TIME, THE DATA REGISTERS CONTAIN THE CORRESPONDING DATA WORD. OTHER BIT PATTERNS DEFINE THE CHECKSUM AND THE BLOCK NUMBER. THESE PATTERNS ARE SIX BITS, OR 240 MICROSECONDS APART.

DURING WRITING, THE NEXT DATA WORD TO BE WRITTEN IS JAMMED INTO THE SHIFT REGISTERS WHEN THE "DATA READY" COMES TRUE, AND THE WORD IS SHIFTED, BIT BY BIT, INTO THE DATA WRITERS. SPECIAL "FINAL" MARK CODES ARE USED TO DIFFERENTIATE READING AND WRITING TIMING. SEE FIGURE 10.2.

A CHECKSUM IS WRITTEN AT THE END OF EACH BLOCK. THIS SUM IS THE ALGEBRAIC SUM, MODULO 65,536, OF ALL THE WORDS IN THE BLOCK. THE CHECKSUM IS CALCULATED AND WRITTEN BY THE WRITE PROGRAM (UTILITIES) DURING THE WRITING OF EACH BLOCK. DURING THE READING OF EACH BLOCK, THE SUM OF THE INCOMING DATA IS CALCULATED AND COMPARED WITH THE CHECKSUM ON THE TAPE.

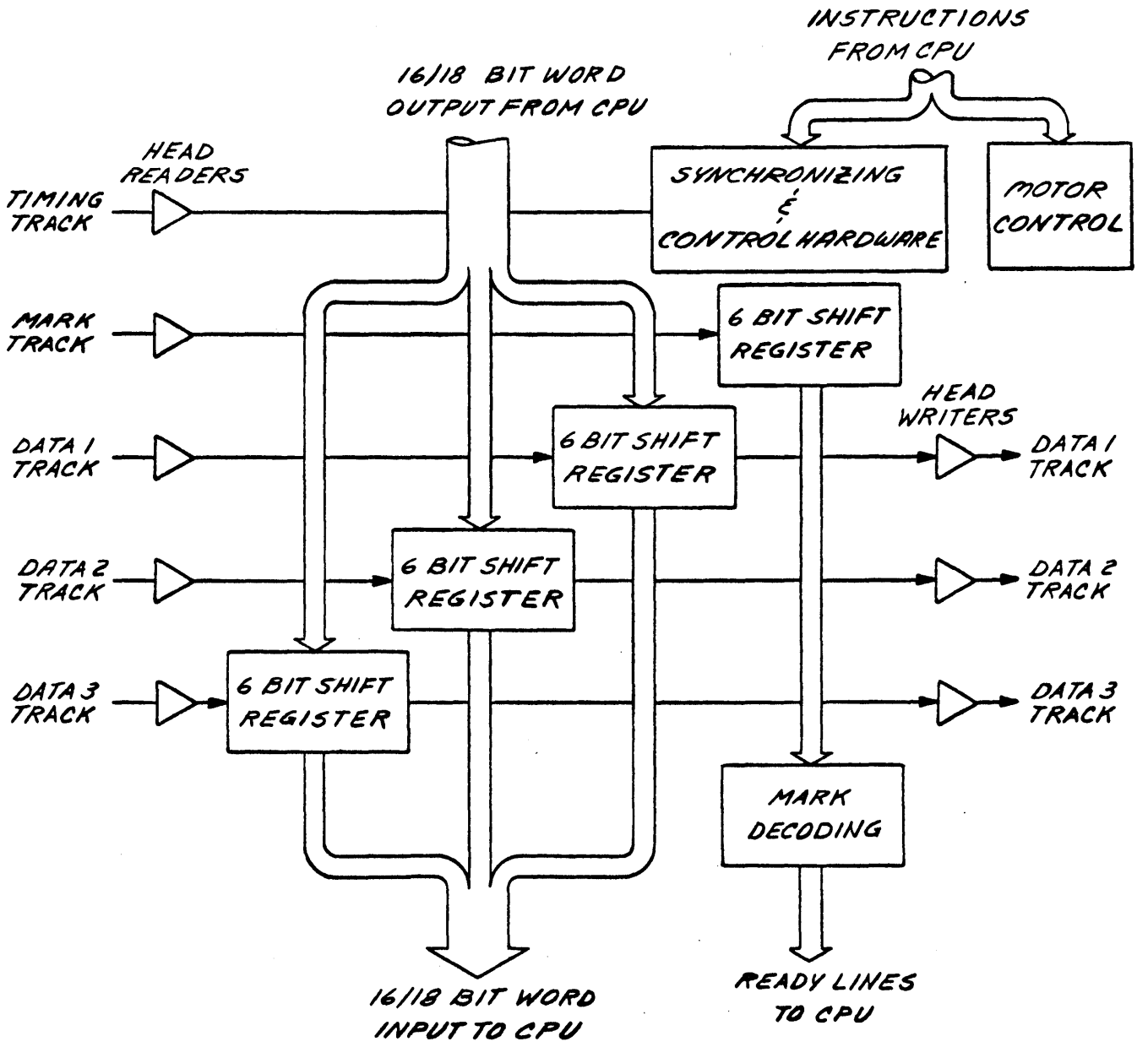
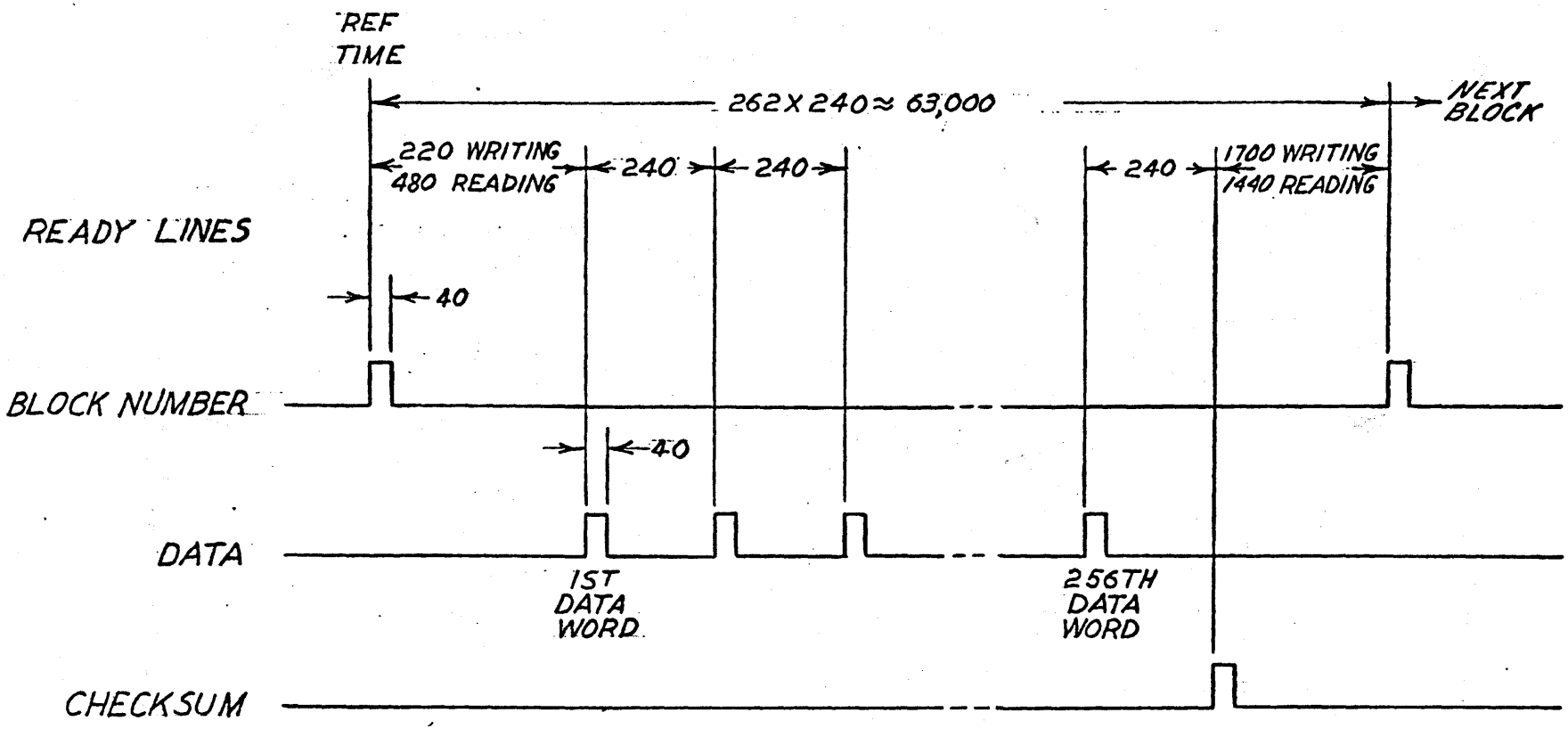


Figure 10.1 Basic LINC Tape Block Diagram



NOTE: THIS TIMING DIAGRAM REPRESENTS POSITIVE TRUE LINES. THE LINCTAPE I/O LINES ARE GROUND TRUE.

FIGURE. 10.2 TIMING FOR FORWARD MOTION.

THE FIVE HEAD SIGNALS ARE DERIVED FROM TEN ACTUAL TRACKS ON THE TAPE. ALL DATA IS RECORDED REDUNDANTLY: I.E., THERE ARE TWO CLOCK CHANNELS, TWO MARK CHANNELS, AND THREE PAIRS OF DATA CHANNELS. IDENTICAL INFORMATION IS RECORDED ON EACH CORRESPONDING TRACK. SEE FIGURE 9.1. WITHIN THE HEAD, THE CORRESPONDING HEAD PAIRS ARE WIRED IN SERIES. IF A DROPOUT SHOULD OCCUR IN A GIVEN TRACK DUE TO DIRT, POOR OXIDE, ETC., THE SIGNAL FROM THE OTHER TRACK IS SUFFICIENTLY LARGE TO INSURE PROPER READING OF THE DATA. THE CLOCK AND MARK CHANNELS ARE AT THE EXTREME EDGES OF THE TAPE TO MINIMIZE SKEW PROBLEMS. THE DATA TRACKS ARE POSITIONED TO MAINTAIN MAXIMUM SEPARATION BETWEEN CORRESPONDING CHANNELS. IT IS THE FULLY REDUNDANT NATURE OF THE RECORDING PROCESS THAT IS RESPONSIBLE FOR THE HIGH RELIABILITY OF THE LINCTAPE SYSTEM.

A TAPE MUST BE PRE-MARKED BEFORE IT CAN BE USED. THIS PRE-MARKING WRITES THE NECESSARY DATA INTO THE TIMING AND MARK TRACKS, AND WRITES THE BLOCK NUMBERS. IN OPERATION, THIS PRE-MARKED DATA CANNOT BE CHANGED. SINCE THE TAPE IS MARKED AND EACH BLOCK IS IDENTIFIED, IT IS UNNECESSARY TO KNOW WHERE THE TAPE IS TO LOCATE A SPECIFIC BLOCK. THE PROGRAM (UTILITIES) SIMPLY READS WHERE IT IS AND TAKES APPROPRIATE ACTION.

A MORE DETAILED BLOCK DIAGRAM OF THE LINCTAPE SYSTEM IS SHOWN IN FIGURES 10.3 AND 10.4.

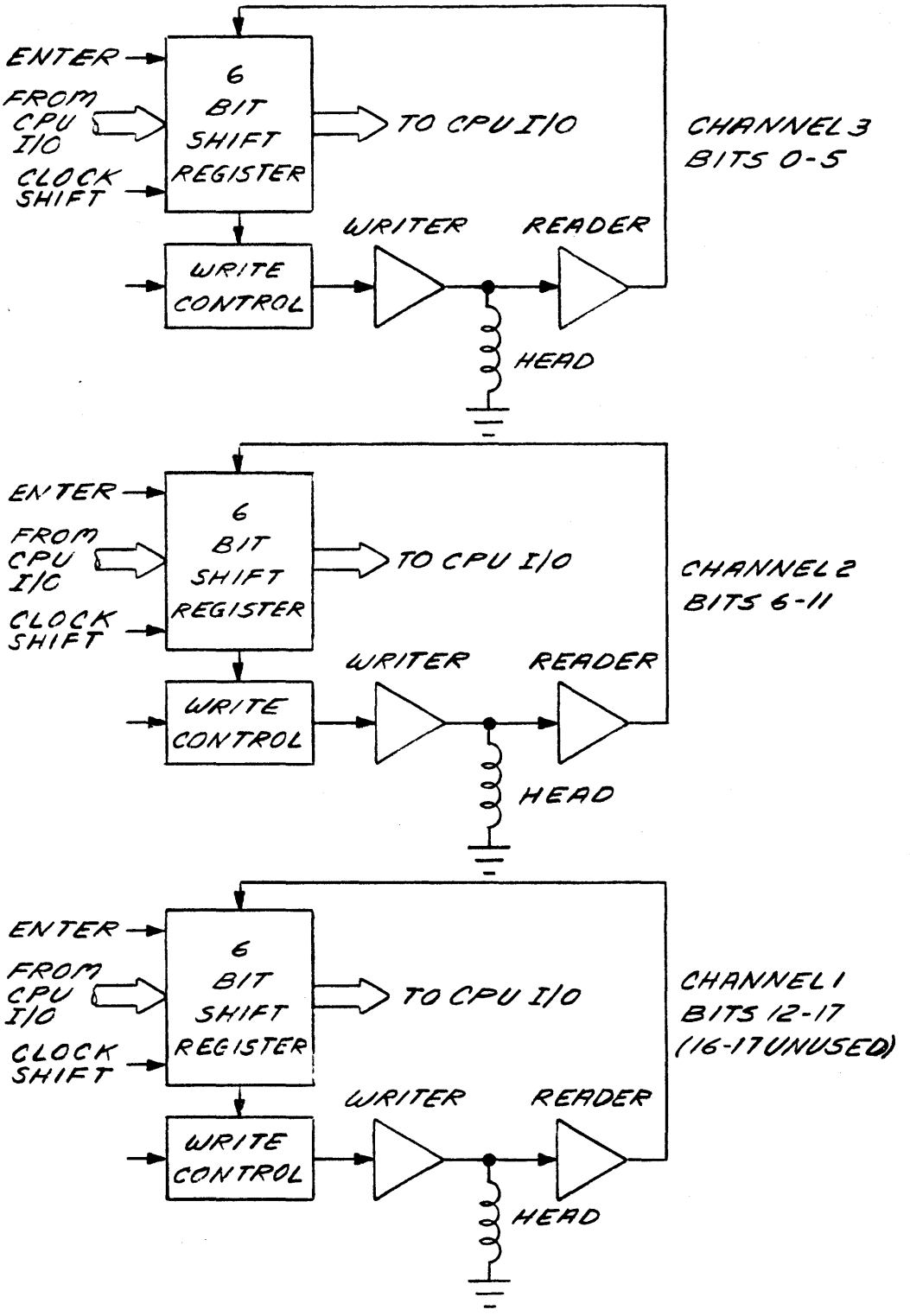


FIGURE 10.3
LINC TAPE BLOCK DIAGRAM:
DATA REGISTERS

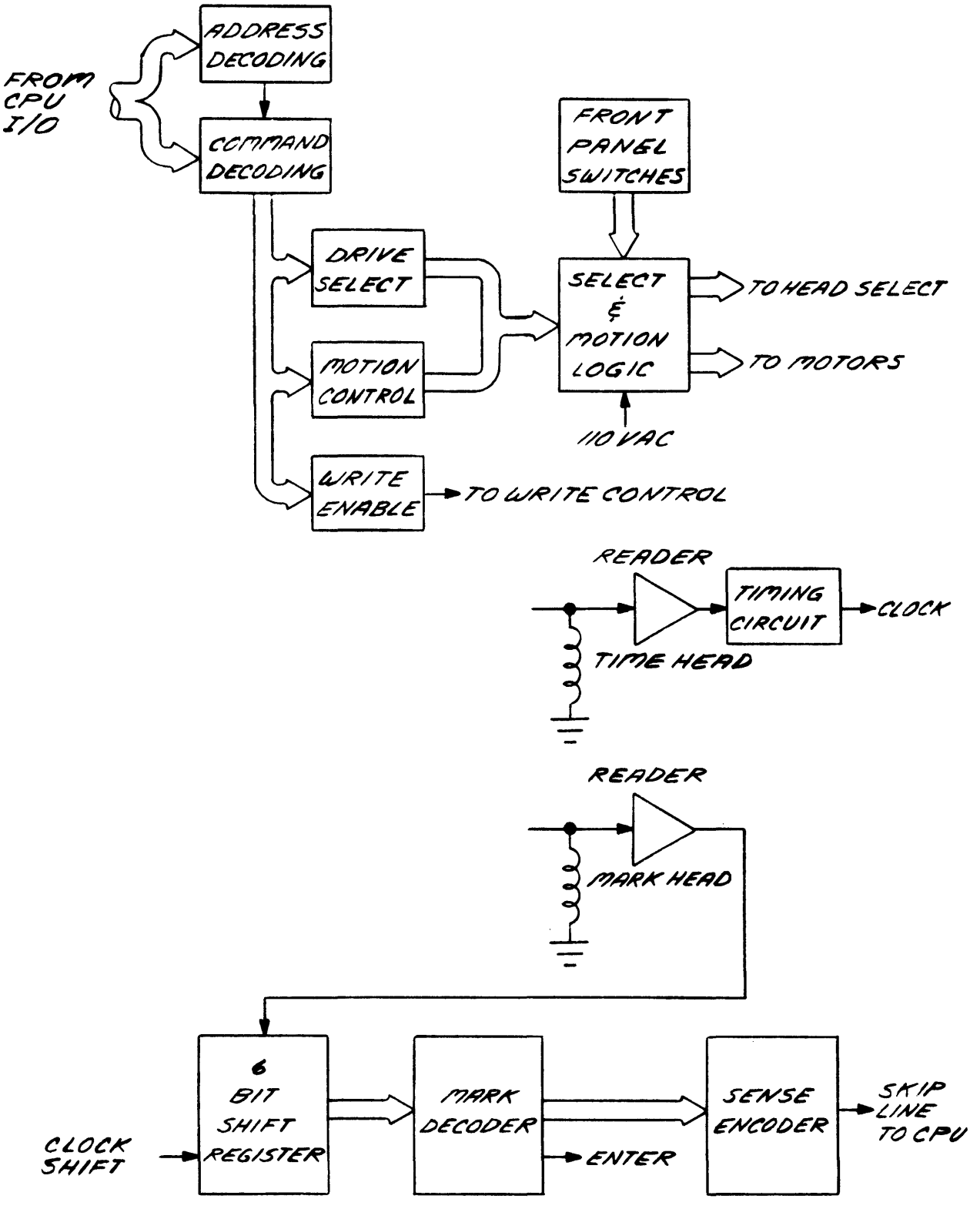


FIGURE 10.4
LINC TAPE BLOCK DIAGRAM:
CONTROL, MARK, & TIMING

11.0 SYSTEM COMPONENTS

THIS SECTION DESCRIBES THE MAJOR COMPONENTS OF THE LINCTAPE SYSTEM AND ILLUSTRATES THEIR LOCATION AND INTER-RELATION. SEE FIGURE 11.1 FOR THE PHYSICAL LAYOUT.

11.1 MASTER CONTROL BOARD

THE MASTER CONTROL BOARD IS THE CENTRAL LOGIC BOARD FOR THE COMPLETE LINCTAPE SYSTEM. IT INTERFACES TO THE COMPUTER, AND TO ALL SLAVE UNITS. IT ALSO CONNECTS TO THE DRIVE CONTROL BOARD AND THE READER-WRITER BOARD. IT IS THE "WIRE-WRAP" BOARD ON THE BACK DOOR OF THE MASTER UNIT. ONLY ONE OF THESE BOARDS IS REQUIRED, REGARDLESS OF THE NUMBER OF SLAVE UNITS ON THE SYSTEM. THE SCHEMATICS FOR THIS BOARD ARE SHOWN IN COI DRAWING NUMBER D-10230-01 (D-10144-01 FOR S/N BELOW 1016).

11.2 DRIVE CONTROL BOARD

THE DRIVE CONTROL BOARD IS LOCATED DIRECTLY BEHIND THE FRONT PANEL. IT CONTAINS MUCH OF THE MOTOR CONTROL LOGIC, THE HEAD SWITCHING DIODES, AND THE FRONT PANEL SWITCH LOGIC. THREE CONNECTORS AT THE TOP OF THE BOARD CONNECT TO 115 VAC, TO LOGIC SIGNALS FROM THE MASTER CONTROL BOARD, AND HEAD SIGNALS RESPECTIVELY. THIS BOARD IS IDENTICAL (EXCEPT FOR JUMPER WIRES) IN THE MASTER AND ALL SLAVE UNITS. THE SCHEMATICS FOR THIS BOARD ARE IN COI DRAWING NUMBER B-10164-01.

11.3 READER/WRITER BOARD

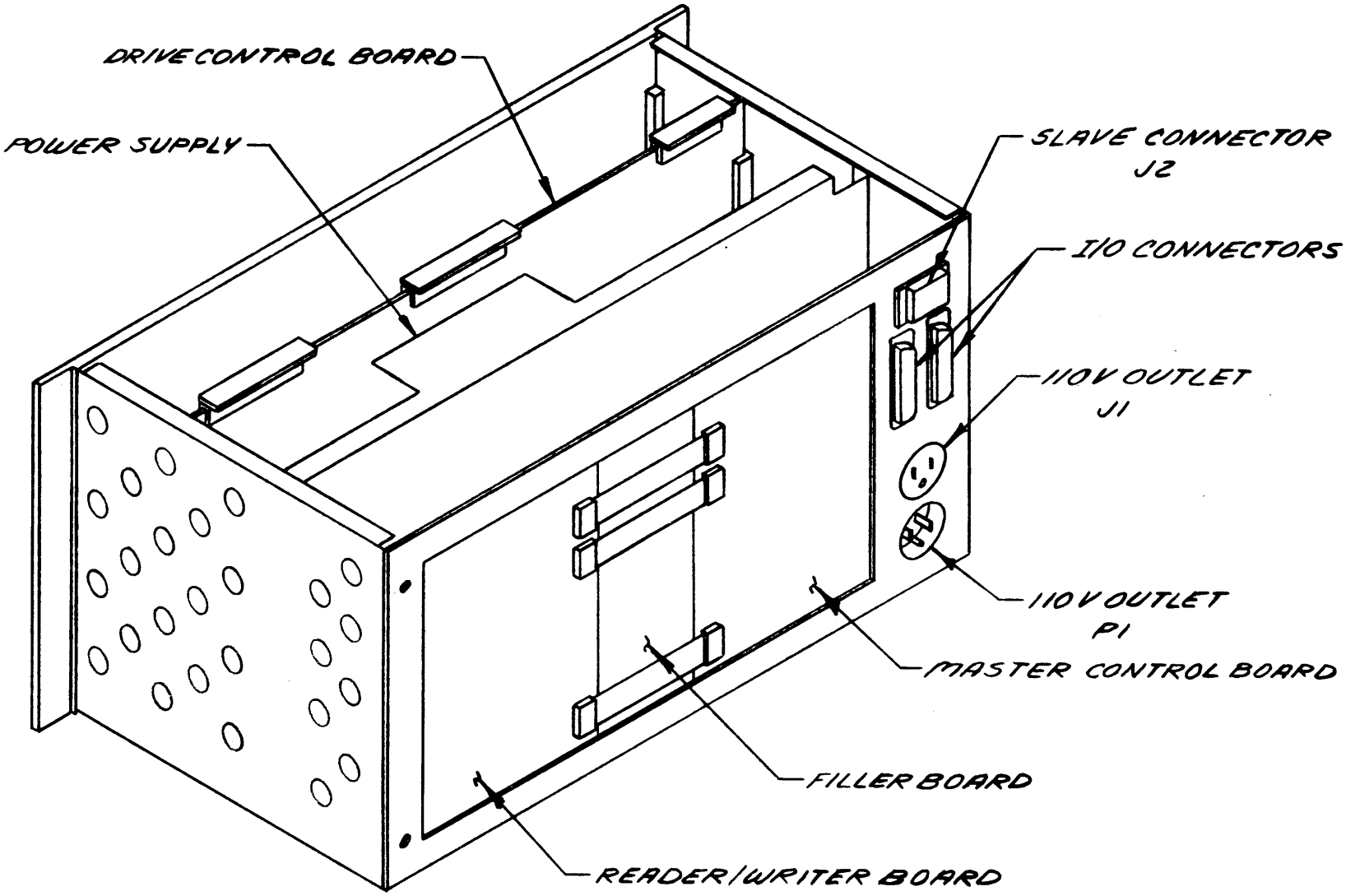
THIS P.C. BOARD, MOUNTED ON THE BACK DOOR OF THE MASTER UNIT, CONTAINS THE HEAD WRITER DRIVERS, AND THE HEAD READER AMPLIFIERS. ONLY ONE READER/WRITER BOARD IS REQUIRED PER SYSTEM, REGARDLESS OF THE NUMBER OF SLAVE UNITS. INTERCONNECTIONS TO THE R/W BOARD ARE MADE THRU THREE 16 PIN CONNECTORS WHICH PLUG INTO THE MAIN CONTROL BOARD. THE SCHEMATIC FOR THIS BOARD IS SHOWN IN COI DRAWING NUMBER D-10198-01 (D-10232-01 FOR S/N BELOW 1016).

11.4 POWER SUPPLY

THE POWER SUPPLY IS BEHIND THE DRIVE CONTROL BOARD. THE TERMINALS CAN BE ACCESSED BY OPENING THE BACK DOOR. IT SUPPLIES THREE D.C. VOLTAGES AND A "POWER FAIL" LOGIC SIGNAL. SEE COI DRAWING NUMBER D-10244-01.

11.5 INTERCONNECTION

THE INTERCONNECTION CABLING BETWEEN THE BOARDS AND CONNECTORS IS SHOWN IN FIGURE 11.2.



SHOWN WITH REAR COVER & TOP REMOVED

FIGURE 11.1
LOCATION OF MAJOR COMPONENTS
OF THE
MASTER LINC TAPE UNIT

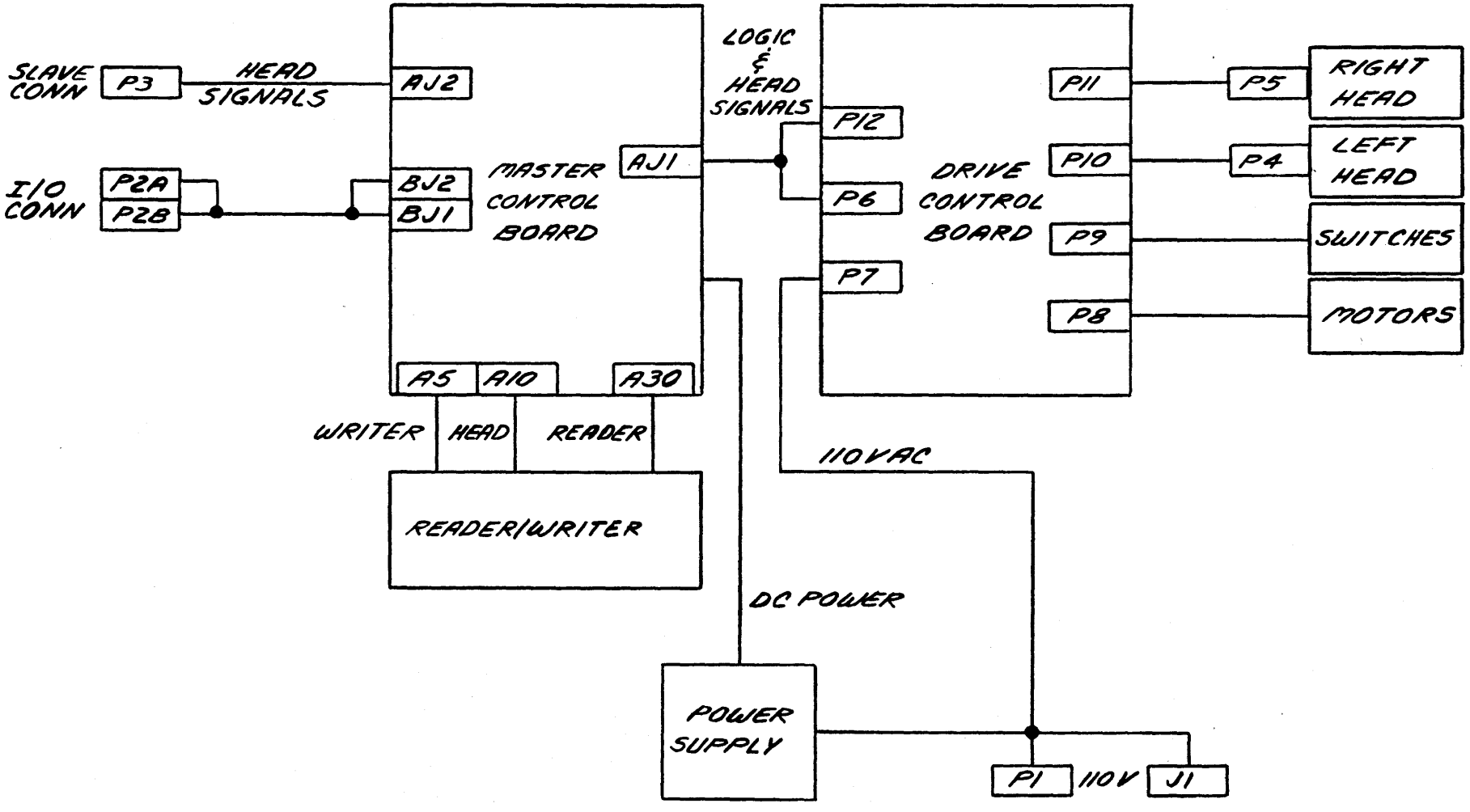


FIGURE 11.2
CABLE INTERCONNECTION

12.0 POWER SUPPLY

THE POWER SUPPLY FURNISHES D.C. POWER FOR THE COMPLETE LINCTAPE SYSTEM. IT IS SUFFICIENT TO SUPPLY ANY NUMBER OF SLAVE UNITS.

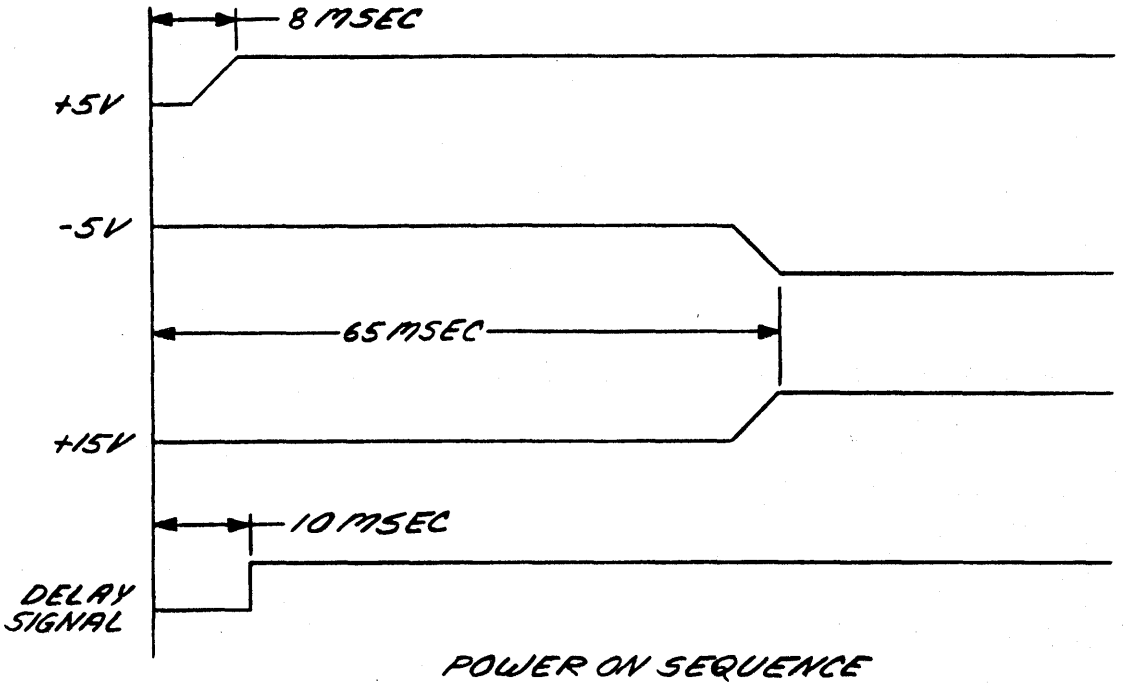
INPUT	115 V, 50/60 HZ
OUTPUT	+5 V @ 2.5 AMPS
	-5 V @ 0.15 AMPS
	+15 V @ 2.0 AMPS

IN ADDITION, THERE IS A LOGIC LEVEL OUTPUT WHICH INDICATES THE LINE STATUS AND IS USED TO PROTECT THE TAPE WHEN POWERING UP OR DOWN, OR WITH POWER FAILURE.

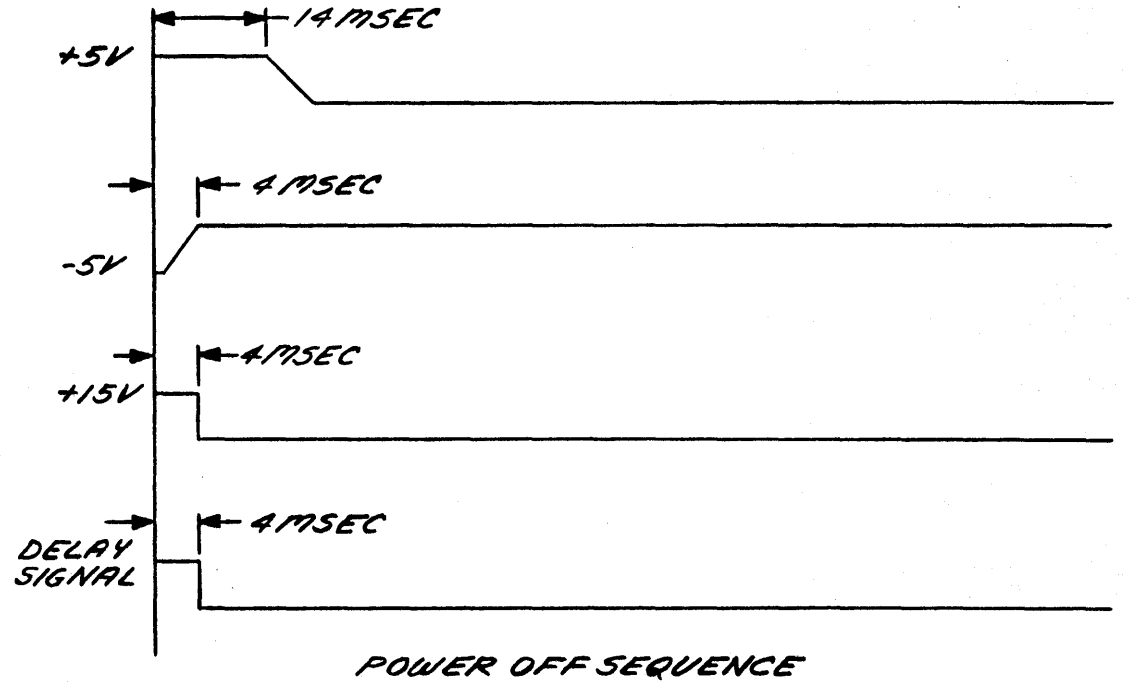
THE +15 VOLT SUPPLY IS DELAYED UPON POWER UP UNTIL THE +5 VOLT SOURCE HAS STABILIZED AND THE LOGIC LEVEL HAS RESET THE CRITICAL REGISTERS TO A SAFE STATE.

WHEN POWERING DOWN, (OR UPON POWER FAILURE) THE +15 VOLT SUPPLY IS CROWBARRED AND THE LOGIC LEVEL IS PULLED DOWN BEFORE THE +5 VOLT SUPPLY CAN FALL. THIS PREVENTS ANY ACCIDENTAL WRITING ON TAPE. THE -5 VOLT SUPPLY IS NOT CRITICAL, AND IS NOT DELIBERATELY SEQUENCED.

FIGURE 12.1 SHOWS THE APPROXIMATE POWER ON AND OFF SEQUENCING.



POWER ON SEQUENCE



POWER OFF SEQUENCE

FIGURE 12.1

13.0 MAINTENANCE

ALTHOUGH LINCTAPE IS RELATIVELY MAINTENANCE-FREE, THERE ARE A FEW MINOR MAINTENANCE STEPS WHICH WILL HELP ASSURE LONG, TROUBLE-FREE SERVICE:

1. PERIODICALLY, CLEAN THE HEADS AND TAPE GUIDES. USE A SOFT, CLEAN CLOTH (JOHNSON STERI-PAD GAUZE PADS ARE GOOD) AND AN APPROVED, UNCONTAMINATED HEAD CLEANING SOLVENT (SUCH AS AMPEX HEAD CLEANER, PART NUMBER 7010110). THIS SHOULD BE DONE FROM ONCE A DAY TO ONCE A WEEK, DEPENDING ON USE AND THE ENVIRONMENTAL CONDITIONS. DO NOT LET THE SOLVENT CONTACT THE TAPE. BE SURE THE HEAD AND GUIDES ARE DRY BEFORE MOUNTING THE TAPE. DO NOT SCRATCH THE HEADS OR THE GUIDES.
2. THE TAPES THEMSELVES OCCASSIONALLY GET DIRTY. THIS IS THE PROBABLE CAUSE OF A TAPE "HUNTING" FOR A BLOCK. ONE CAN BE CLEANED BY PASSING IT BETWEEN TWO CLEAN GAUZE PADS. MOUNT THE TAPE IN THE USUAL MANNER, PLACE ONE PAD ON THE HEAD AND HOLD THE OTHER ON THE TAPE, AND WIND THE TAPE SO THE WHOLE LENGTH PASSES BETWEEN THE PADS. BE CAREFUL NOT TO DAMAGE THE EDGES OF THE TAPE.

   CAUTION: NEVER USE STICKY TAPE, SUCH AS "SCOTCH" TAPE OR ADHESIVE LABELS ON THE TAPE ITSELF. IN TIME, THE GUMMY MATERIAL TENDS TO DISTRIBUTE ITSELF OVER THE TAPE AND CAUSE DROPOUTS. PUT LABELS ON THE REEL, NOT THE TAPE. ALSO, KEEP TAPES AWAY FROM STRONG MAGNETIC FIELDS, SUCH AS NEAR TRANSFORMERS, MOTORS, OR FLUORESCENT LIGHT BALLASTS.

WHEN DIAGNOSING TROUBLES, THE FOLLOWING CHECKS ARE HELPFUL:

1. DO THE WRITE PROTECT LIGHTS WORK? IF SO, THE +15 VOLT IS PROBABLY OK.
2. DO THE LOAD AND REWIND BUTTONS WORK? FOR BOTH DRIVES? CAN THE RELAYS BE HEARD? IF SO, THE 110V AND +5 VOLT SUPPLY ARE PROBABLY OK.
3. ARE THE SHAFTS FREE TO TURN WITHOUT BEING SLOPPY? ARE ALL FOUR OF THEM ABOUT THE SAME? DO THE REELS SNAP ONTO THE HUBS PROPERLY? ARE THEY SO LOOSE THAT THE REELS SQUEAK WHEN MOTION STARTS?
4. ARE THE HEADS, GUIDES, AND TAPE CLEAN? IF THESE ARE DIRTY, THEY WILL CAUSE DROPOUTS.
5. IS THE TROUBLE INTERMITTENT? DOES IT COME AND GO WHEN WIRES ARE MOVED? IS IT ASSOCIATED WITH ONE DRIVE? ONE TAPE?
6. DOES THE CPU WORK? WITH OTHER PERIPHERALS?
7. DOES THE CPU TRANSFER DATA IN AND OUT OF THE REGISTERS PROPERLY?
8. DOES THE CPU START AND STOP TAPE? CAN THE RELAYS BE HEARD?
9. DOES THE CPU SELECT DRIVES? CAN THE RELAYS BE HEARD?
10. DOES THE CPU FIND BLOCK MARKS? DATA MARKS? CHECK MARKS?

BASED ON THE ABOVE OBSERVATIONS, THE FOLLOWING FAULTS MIGHT OCCUR:

1. POWER OFF OR SYSTEM NOT PLUGGED IN.
2. FUSE BLOWN: THERE ARE FOUR FUSES IN THE POWER SUPPLY AND ONE IN EACH OF THE DRIVE CONTROL BOARDS (MASTER AND SLAVES).
3. LOOSE CONNECTIONS: CHECK THE CONNECTORS ON THE REAR PANEL, AND ALL CONNECTORS INSIDE THE UNITS. ARE ALL TERMINALS TIGHT AND CLEAN? SOMETIMES TERMINALS CAN BE SQUEEZED SLIGHTLY TO MAKE THEM TIGHTER. EDGE TERMINAL FINGERS CAN BE CLEANED WITH AN ERASER.
4. LOOSE IC'S: REMOVE THE I.C. COVER AND PRESS ALL IC'S FIRMLY IN PLACE. BE SURE NONE ARE MISSING.
5. POWER FAIL CROWBAR HUNG UP: TURN OFF POWER FOR A FEW SECONDS AND TRY AGAIN.
6. MECHANICAL FAILURE: CHECK TO BE SURE THE HUBS AND SPROCKETS ARE FIRMLY FASTENED TO THE SHAFTS. INSPECT THE BELT FOR WEAR. BE SURE THEY ARE MECHANICALLY FREE. THE HUB SPRING TENSION CAN BE CHANGED BY MOVING OR REPLACING THE RUBBER BAND UNDER THE SPRING.

SOME IMPORTANT TIMING POINTS THAT CAN BE OBSEVED WHILE THE TAPE IS MOVING FORWARD ARE:

TREA+ 40 US SQUARE WAVE

ALL OTHER READER SIGNALS ARE RECTANGULAR WAVES WITH TRANSITIONS 20 OR 40 US APART

ACIP+ 130 MS PULSE WHEN STARTING MOTORS OR CHANGING THEIR DIRECTION

BMRK+, GMRK+ 40 US PULSE EVERY 63 MS

DMRK+ 255 40 US PULSES EACH BLOCK, 240 US APART

FMTN+ MUST BE ON FOR MARKS TO DECODE, BUT THE READER SIGNALS CAN BE MONITORED BY MANUALLY MOVING TAPE.

^^^

APPENDIX A. BOOTSTRAP

```
;    LINCTAPE NOVA BOOTSTRAP ROUTINE  9/27/71
;
; THERE ARE THREE METHODS OF BOOTSTRAPPING,
; DEPENDING UPON THE HARDWARE CONFIGURATION:
;    (1) SUPERNOVA PROGRAM LOADER,
;    (2) NOVA 800/1200 SERIES AUTOPROGRAM OPTION, OR
;    (3) NOVA OR 800/1200 SERIES MANUAL BOOTSTRAP.
;
; THE LINCTAPE BOOTSTRAP CAN BE USED WITH ANY
; OF THESE TO LOAD IN THE LINCTAPE UTILITIES AND LOAD
; AND EXECUTE THE EXECUTIVE SYSTEM ROUTINE.
;
; THIS EXECUTIVE SYSTEM ROUTINE WILL DEPEND
; ON THE TYPE OF TAPE BEING USED. THE KEYBOARD
; EXECUTIVE ROUTINE IS ONE EXAMPLE OF AN
; EXECUTIVE SYSTEM ROUTINE.
;
;
;     <<<<< PROCEDURES >>>>>
;
; THE PROCEDURE FOR BOOTSTRAPPING WITH THE SUPERNOVA
; PROGRAM LOADER OR THE NOVA 800/1200 SERIES
; AUTOPROGRAM OPTION IS:
;    (1) SET THE DATA SWITCHES TO THE LINCTAPE DEVICE
;        NUMBER (USUALLY 74),
;    (2) PUT A LINCTAPE WITH THE NOVA BOOTSTRAP ROUTINE
;        ON DRIVE 0, WITH THE MARKER TO THE RIGHT
;        OF THE HEAD.  LEAVE IN TENSION MODE,
;    (3) PRESS RESET,
;    (4) PRESS PROGRAM LOAD.  THE LINCTAPE WILL
;        MOVE AND STOP, AND THE TELETYPE WILL RESPOND
;        WITH THE APPROPRIATE EXECUTIVE SYSTEM
;        RESPONSE.
;
; THE PROCEDURE FOR BOOTSTRAPPING WHEN USING
; THE MANUAL BOOTSTRAP IS:
;    (1) BE SURE THE MANUAL BOOTSTRAP IS IN CORE.
;        IT IS LISTED BELOW,
;    (2) SET THE DATA SWITCHES TO X7770, WHERE
;        X7777 IS THE HIGHEST CORE LOCATION,
;    (3) PUT A LINCTAPE WITH THE NOVA LOADER ON
;        DRIVE 0, WITH THE MARKER TO THE RIGHT
;        OF THE HEAD.  LEAVE IN TENSION MODE,
;    (4) PRESS RESET,
;    (5) PRESS START.  THE LINCTAPE WILL MOVE
;        AND STOP, AND THE TELETYPE WILL RESPOND WITH
;        THE APPROPRIATE EXECUTIVE SYSTEM RESPONSE.
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; TO LOAD THE MANUAL BOOTSTRAP INTO CORE:
;    (1) SET THE DATA SWITCHES TO X7755 (1ST LOC),
;    (2) PRESS EXAMINE,
;    (3) SET THE DATA SWITCHES TO 177737 (1ST WORD),
;    (4) PRESS DEPOSIT,
;    (5) SET THE DATA SWITCHES TO THE NEXT WORD,
;    (6) PRESS DEPOSIT NEXT,
;    (7) REPEAT (5) AND (6) UNTIL ALL WORDS ARE
;        LOADED.
;
;  LOC     WORD
; -----   ------
; X7755   177737  COUNT: -41              ;WORDS LOADED
; X7756   126420  GET:   SUBZ  1,1        ;CLEAR AC1 & SET C
; X7757   0636YY         SKPDN LINC       ;BYTE READY?
; X7760   000777         JMP   .-1        ;NO: WAIT
; X7761   0605YY         DIAS  0,LINC     ;YES: GET BYTE
; X7762   107363         ADDCS 0,1,SNC    ;MERGE: ANOTHER?
; X7763   000774         JMP   .-4        ;YES: GET IT
; X7764   125305         MOVS  1,1,SNR    ;NO: SWAP BACK: ZERO?
; X7765   000771         JMP   GET        ;YES: TRY AGAIN
; X7766   045041         STA   1,41,2     ;STORE IT
; X7767   001400         JMP   0,3        ;RETURN WITH WORD
; X7770   0605YY  BOOT:  DIAS  0,LINC     ;START LINCTAPE
; X7771   030764         LDA   2,COUNT    ;SET WORD COUNTER
; X7772   004764         JSR   GET        ;GET A WORD
; X7773   151404         INC   2,2,SZR    ;INCR & TEST
; X7774   000776         JMP   .-2        ;NOT THRU
; X7775   000002         JMP   MANLD      ;GO TO MAN PRELOAD
; X7776           ; RESERVE FOR BINARY LOADER ADDRESS
; X7777           ; RESERVE FOR BINARY LOADER JUMP
;
;         WHERE:
;           X7777 = HIGHEST CORE LOCATION
;                     CORE  X     CORE  X
;                      4 K  0     20 K  4
;                      8 K  1     24 K  5
;                     12 K  2     28 K  6
;                     16 K  3     32 K  7
;                YY = LINCTAPE DEVICE NUMBER (USUALLY 74)
```

^^^

```
;      <<<<< PROGRAM SEQUENCE >>>>>
;
; THERE ARE FOUR SECTIONS TO THE COMPLETE BOOTSTRAP
; ROUTINE, NOT INCLUDING THE HARDWARE ROUTINES.
; THESE FOUR SECTIONS RESIDE IN THE FIRST THREE
; BLOCKS OF LINCTAPE:
;     (1) PRELOADER
;     (2) UTILITY LOADER
;     (3) LINCTAPE UTILITIES
;     (4) EXECUTIVE SYSTEM ROUTINE.
; REFER TO THE "HOW TO USE THE NOVA COMPUTERS"
; MANUAL, SECTIONS 2.3 AND 3.3 FOR DETAILS ON THE
; HARDWARE LOADERS.
;
; THE PRELOADER IS NEAR THE END OF BLOCK -10 OF THE
; LINCTAPE IN BYTE FORM.  THE BEGINNING OF BLOCK
; -10 IS ALL ZEROES.  THE UTILITY LOADER, ALSO
; IN BYTE FORM, IS AT THE BEGINNING OF BLOCK -7.
; THE UTILITIES ARE IN WORD FORM AT THE END OF BLOCK
; -7, AND THE EXECUTIVE SYSTEM, IN WORD FORM, FILLS
; BLOCK -6.
;
; THE SUPERNOVA OR THE MANUAL BOOTSTRAP SKIPS
; LEADING ZEROES, AND LOADS THE PRELOADER
; PROGRAM FROM LINCTAPE BLOCK -10 INTO CORE
; AT LOCATIONS 0 THRU 40.  THE SUPERNOVA
; THEN JUMPS TO LOC 40, WHILE THE MANUAL
; BOOTSTRAP JUMPS TO LOC 2 OF THE PRELOADER.
;
; THE PRELOADER SETS THE DEVICE NUMBER AND IN TURN
; LOADS THE UTILITY LOADER FROM BLOCK -7 INTO CORE
; LOCATIONS 142 THRU 216, AND EXECUTES AT LOC 216.
;
; THE NOVA 800/1200 AUTOLOADER LOADS AND EXECUTES
; ITS OWN BOOTSTRAP FROM HARDWARE INTO LOCATIONS
; 0 THRU 37.  IT THEN LOADS THE PRELOADER (WHICH
; IS IGNORED) AND THE UTILITY LOADER INTO CORE
; LOCATIONS 100 THRU 216, AND EXECUTES THE
; UTILITY LOADER AT LOCATION 216.
;
; THE UTILITY LOADER IS THUS LOADED AND EXECUTED
; AT 216 BY ANY OF THE BOOTSTRAP CONFIGURATIONS.
; IT SIZES CORE, AND LOADS THE UTILITIES JUST BELOW
; THE BINARY TAPE LOADER AT X7600.
;
; THE LINC UTILITIES THEN REST AT X7400 THRU X7577.
; THE PROGRAM THEN JUMPS TO "START" IN THE UTILITIES,
; READS THE EXECUTIVE SYSTEM FROM BLOCK -6 INTO CORE
; LOCATIONS X7000 THRU X7377, AND FINALLY STOPS
; THE TAPE AND JUMPS TO LOCATION X7377 WITH
; AC3 = ADDRESS OF "CLINC" (X7400) OF THE UTILITIES.
;
; SOME LOCATIONS NEAR THE BOTTOM OF CORE ARE
; WIPED OUT BY THE BOOTSTRAP PROCESS. THEY ARE:
;   SUPERNOVA      MANUAL     AUTOLOADER
;      0- 40         0- 40       0-37
;    142-216       142-216     100-216
;      377                       377
```

^^^

```
                ; NOW THE PRELOADER PROGRAM
                ;
       000010           .RDX  8
       000002           .LOC  2
00002  021775  MANLD:   LDA   0,-3,3   ; MANUAL ENTRY LOC: GET D.N.
00003  000005           JMP   .+2
00004  060477  PRELOD:  READS 0         ; GET DEVICE NUMBER
00005  024026           LDA   1,C77
00006  123400           AND   1,0       ; MASK 6 BITS
00007  024030           LDA   1,GET+1
00010  107000           ADD   0,1
00011  044030           STA   1,GET+1   ; SET SKIP COMMAND
00012  024032           LDA   1,GET+3
00013  107000           ADD   0,1
00014  044032           STA   1,GET+3   ; SET INPUT COMMAND
00015  126440           SUBO  1,1       ; CLEAR AC1 & RESET CARRY
00016  004030           JSR   GET+1     ; GO AFTER BYTE
00017  101065           MOVC  0,0,SNR   ; ZERO BYTE?
00020  000016           JMP   .-2       ; YES: IGNORE IT
00021  004027           JSR   GET       ; NO: GET NEXT FULL WORD
00022  046025           STA   1,@PTR1   ; STORE THE WORD
00023  010142           ISZ   142       ; LAST WORD?
00024  000021           JMP   .-3       ; NO: GET ANOTHER WORD
00025  000141  PTR1:    141             ; POINTER TO STORE & JUMP
00026  000077  C77:     77
                ; GET A WORD SUBR. GET A BYTE SUBR
00027  126420  GET:     SUBZ  1,1       ; CLEAR AC1 & SET CARRY
00030  063600           SKPDN 0         ; BUFFER READY?
00031  000030           JMP   .-1       ; NO: WAIT
00032  060500           DIAS  0,0       ; YES: INPUT THE BYTE
00033  107363           ADDCS 0,1,SNC   ; SWAP BYTES. NEED ANOTHER?
00034  000030           JMP   .-4       ; YES: GO GET IT
00035  125300           MOVS  1,1       ; NO: SWAP BACK
00036  001400           JMP   0,3       ; RETURN WITH WORD/BYTE
00037  177777           -1
00040  000004  FORTY:   JMP   PRELOD    ; SUPERNOVA ENTRY LOCATION
```

```
^^^

                        ; NOW THE UTILITY LOADER
                        ;
        000010                  .RDX    8
        000077                  .LOC    77
00077   000377  SYNC:   377             ; SYNC BYTE
00100   177661  COUNT:  SYNC-END        ; WORD COUNTER
        000142          .LOC    142
00142   177723          .-END-1
                        ; SET DEVICE NUMBER
00143   020030  GOGO:   LDA     0,GET+1 ; GET I/O WORD
00144   024213          LDA     1,K77
00145   123400          AND     1,0     ; GET DEVICE NUMBER
00146   024206          LDA     1,GETW
00147   107000          ADD     0,1
00150   044206          STA     1,GETW  ; SET SKIP COMMAND
00151   024210          LDA     1,GETW+2
00152   107000          ADD     0,1
00153   044210          STA     1,GETW+2 ; SET INPUT COMMAND
                        ; SIZE CORE
00154   020214          LDA     0,ONEK  ; MEMORY SIZE INCREMENT
00155   034215          LDA     3,HIGH  ; HIGHEST OPEN MEMORY
00156   116400          SUB     0,3     ; MOVE DOWN TO NEXT CORE
00157   055777          STA     3,-1,3  ; TRIAL STORAGE
00160   031777          LDA     2,-1,3  ; GET IT AGAIN
00161   156414          SUB#    2,3,SZR ; TEST FOR MATCH
00162   000156          JMP     .-4     ; NO MATCH: TRY AGAIN
                        ; SKIP ZERO BYTES
00163   004206          JSR     GETW    ; AC2 = HIGHEST OPEN CORE
00164   101025          MOVZ    0,0,SNR ; IGNORE LEADING ZEROES
00165   000163          JMP     .-2
                        ; LOAD THE UTILITIES
00166   040214          STA     0,ONEK  ; SAVE COUNT "LTSIZ"
00167   113000          ADD     0,2     ; POINT TO LOAD ADDR
00170   050213          STA     2,K77   ; SAVE POINTER
00171   004206          JSR     GETW    ; GET A WORD
00172   041000          STA     0,0,2   ; STORE IT
00173   151400          INC     2,2     ; INCR POINTER
00174   010214          ISZ     ONEK    ; INCR COUNTER
00175   000171          JMP     .-4     ; IF NOT DONE, GO BACK
                        ; SET UP TO LOAD KEYBOARD EXEC
00176   030213          LDA     2,K77   ; IF DONE, GET 1ST UTIL LOC
00177   051170          STA     2,LLOC-CLINC,2 ; & PUT IN LLOC
00200   025163          LDA     1,SIZE-CLINC,2 ; GET WORDS/BLOCK
00201   132400          SUB     1,2     ; SET 1ST CORE LOC
00202   126520          SUBZL   1,1     ; SET NO OF BLOCKS TO 1
00203   020212          LDA     0,BLOCK ; SET NEXT BLK NO
00204   034213          LDA     3,K77
00205   001577          JMP     START-CLINC,3 ; GOTO START
                        ; GET WORD SUBROUTINE
00206   063600  GETW:   SKPDN   0       ; BUFFER READY?
00207   000206          JMP     .-1     ; NO: WAIT
00210   060500          DIAS    0,0     ; READ WORD INTO AC0
00211   001400          JMP     0,3     ; RETURN WITH FULL WORD
00212   177772  BLOCK:  -6
00213   000077  K77:    77
00214   001000  ONEK:   1000
00215   100600  HIGH:   77600+1000      ; SAVE BINARY LOADER
00216   000143  END:    JMP     GOGO    ; ENTER BOOTSTRAP HERE
```

^^^

APPENDIX B. LINCTAPE UTILITIES

THESE UTILITIES ARE SHOWN ASSEMBLED FOR A 4K MACHINE. HOWEVER, THEY ARE POSITION INDEPENDENT, AND THEREFORE WILL BE IDENTICAL FOR ANY SIZE MACHINE.

```
                    ;  NOW THE LINCTAPE UTILITIES ------
                    ;
                    ; BLOCK -7 MUST CONTAIN ZEROES BETWEEN THE
                    ; LAST WORD OF THE UTILITY LOADER ADN "LTSIZ".
          000010              .RDX  8
          007377              .LOC  7377
    07377 177600    LTSIZ:    .-START     ; LINCTAPE UTILITY SIZE
                    ;
                    ;   ENTRIES TO LINC UTILITIES
                    ;     WLINC:  WRITE & CHECK
                    ;     RLINC:  READ & CHECK
                    ;     CLINC:  CHECK ONLY
                    ;*** USER MUST SELECT DRIVE BEFORE CALL WITH "DOB -,74"
                    ;  ALL CALLS MADE BY 'JSR' TO ONE OF THE ABOVE,
                    ;       WITH AC0= FIRST BLOCK #
                    ;            AC1= NUMBER OF BLOCKS TO BE PROCESSED
                    ;            AC2= FIRST CORE ADDRESS
                    ;
                    ;            AC1 MAY =0. THIS IS THE "FIND" FUNCTION.
                    ;            AC2 IF NEGATIVE, REPRESENTS THE
                    ;       ONE'S COMPL OF THE REAL ADDRESS, AND CAUSES
                    ;       THE BLOCK SEARCH TO START IN REVERSE.
                    ;
                    ;  NORMAL RETURNS ARE INDICATED BY AC1=0.
                    ;         AC2= NEXT CORE ADDRESS
                    ;         AC0= NEXT BLOCK #
                    ;
                    ;  ABNORMAL RETURNS HAVE THE ERROR CODE IN AC1:
                    ;       AC1=1   CHECKSUM ERROR. AC0= BAD BLOCK #
                    ;
                    ;       AC1=2   BLOCK SIZE ERROR. AC0= BAD BLOCK.
                    ;               AC2= EXCESS OF MARKS IN BLOCK.
                    ;               AC3= EXPECTED #.
                    ;
                    ;       AC1=4   ILLEGAL BLOCK.  AC0= TARGET BLOCK.
                    ;               AC2= NEXT CORE ADDR.
                    ;               AC3= HIGHEST LEGAL BLOCK.
                    ;
                    ;       AC1=8   DRIVE STATUS ERROR. AC3= DRIVE STATUS,
                    ;               BIT 1= PROTECTED, BIT 0= NOT READY.
                    ;
    07400 054431    CLINC:  STA 3,SAC3
    07401 152400            SUB 2,2     ;ADDRESS DOESN'T MATTER
    07402 000417            JMP CHKZ
    07403 054426    RLINC:  STA 3,SAC3
    07404 034430            LDA 3,D2R   ; SET READ RTNE. TO STORE DATA
    07405 000415            JMP READZ
    07406 054423    WLINC:  STA 3,SAC3
    07407 034423            LDA 3,D1W
    07410 054510            STA 3,D1XX  ; SET UP FOR WRITE
    07411 044501            STA 1,D2XX   ;SAVE PARAMS
    07412 050416            STA 2,SAC2
    07413 004423            JSR DO       ; FIND & WRITE BLOCKS
```

```
07414 024476  RAW:    LDA 1,D2XX  ;RESTORE PARAMS
07415 122400          SUB 1,0
07416 030412          LDA 2,SAC2
07417 151113          MOVL# 2,2,SNC  ;MAKE ADDR. NEG FOR REVERSE
07420 150000          COM 2,2
07421 034473  CHKZ:   LDA 3,D2C   ; NO STORE ON CHECK
                      ;
07422 054470  READZ:  STA 3,D2XX
07423 034410          LDA 3,D1RC
07424 054474          STA 3,D1XX   ; SET UP FOR READ OR CHECK
07425 004411          JSR DO       ; FIND & READ BLOCKS
07426 060274  EXIT:   NIOC LINC    ; STOP DRIVE
07427 002402          JMP @SAC3    ; RETURN TO CALLER
07430 000000  SAC2:   0
07431 000000  SAC3:   0
                      ;
07432 021000  D1W:    LDA 0,0,2    ; DATA FOR WRITE SWITCH
07433 000750  D1RC:   JMP READ-D1XX,1    ; FOR READ SWITCH
07434 132512  D2R:    SUBL# 1,2,SZC  ;DO THIS FOR READ, NOT CHECK
07435 000000  RETU:   0
                      ;
07436 054777  DO:     STA 3,RETU
07437 075474          DIB 3,LINC     ; CHECK DRIVE READY
07440 175112          MOVL# 3,3,SZC
07441 000446          JMP E4
07442 151113          MOVL# 2,2,SNC ; LOOK AT ADDR.
07443 000410          JMP FINDF      ; IF POS, START FORWARD
07444 150000          COM 2,2      ; IF NEG, START REVERSE
                      ;
07445 176400  FINDR:  SUB 3,3        ; ENTER HERE FOR REV.
07446 162000          ADC 3,0        ;POINT TO TARGET-1
07447 060374          NIOP LINC      ;START REV
07450 004467          JSR GETBLOCK
07451 101401  FINDN:  INC 0,0,SKP
07452 000776          JMP .-2        ; KEEP GOING IF ABOVE OR ON
07453 060174  FINDF:  NIOS LINC      ; ENTER HERE FOR FWD.
07454 004463          JSR GETBLOCK
07455 000777          JMP .-1        ; KEEP GOING IF BELOW
07456 175224          MOVZR 3,3,SZR ; FOUND TARGET IF =0
07457 000766          JMP FINDR
07460 125005  FOUND:  MOV 1,1,SNR   ;LAST BLOCK?
07461 002754          JMP @RETU      ; YES, EXIT FROM "DO"
07462 166000          ADC 3,1        ;AC3=0. DECR BLOCK COUNTER
07463 040474          STA 0,TEMP1
07464 044474          STA 1,TEMP2
07465 024476          LDA 1,SIZE
07466 147000          ADD 2,1      ;POINT TO END OF BLOCK.
07467 000431          JMP D1XX
```

^^^

```
07470 063674  READ:   SKPDN LINC    ; WAIT FOR DATA
07471 000777          JMP .-1
07472 063474          SKPBN LINC
07473 000416          JMP RDAT
07474 060474  RCHK:   DIA 0,LINC    ; INPUT CHECKSUM
07475 116405          SUB  0,3,SNR
07476 000434          JMP SCHK      ; SHOULD = ACCUM. CHKSM
07477 024465  E1:     LDA 1,C1      ; CHECKSUM ERROR
07500 000403          JMP .+3
07501 034462  E2:     LDA 3,SIZE
07502 024463          LDA 1,C2
07503 020454          LDA 0,TEMP1
07504 000722          JMP EXIT
07505 024461  E3:     LDA 1,C4      ; ILLEGAL BLOCK NUMBER
07506 000720          JMP EXIT
07507 024460  E4:     LDA 1,C8      ; DRIVE STATUS ERROR
07510 000716          JMP EXIT
07511 060474  RDAT:   DIA 0,LINC    ;INPUT DATA WORD
07512 132512  D2XX:   SUBL# 1,2,SZC  ;"JMP .+2" FOR CHECK
07513 041000          STA 0,0,2
07514 000402  D2C:    JMP .+2
07515 061074  WDAT:   DOA 0,LINC    ; WRITE DATA
07516 117000  BLOOP:  ADD 0,3       ; UPDATE CHKSM ACCUM.
07517 151400          INC 2,2       ; UPDATE POINTER
07520 021000  D1XX:   LDA 0,0,2     ; FOR READ & CHECK, "JMP READ"
07521 063074          DOC 0,LINC   ;WRITERS ON
07522 063674          SKPDN LINC
07523 000777          JMP .-1       ; WAIT FOR DATA, CHECK MARK
07524 063474          SKPBN LINC
07525 000770          JMP WDAT      ; DATA MARK
07526 075074  WCHK:   DOA 3,LINC    ; WRITE CHECKSUM
07527 075474          DIB 3,LINC   ;INPUT DRIVE STATUS
07530 175004          MOV 3,3,SZR
07531 000756          JMP E4       ;MUST BE READY & UNPROTECTED
07532 132414  SCHK:   SUB# 1,2,SZR ;WAS BLOCK RIGHT SIZE?
07533 000746          JMP E2
07534 020423  NEXT:   LDA 0,TEMP1   ;BLOCK FINISHED
07535 024423          LDA 1,TEMP2   ;RESTORE BLOCK COUNTER
07536 000713          JMP FINDN   ; NEXT BLOCK
                      ;
                      ;
```

^^^

```
07537 054420  GETBLOCK: STA 3,TEMP1
07540 034421           LDA 3,MLIM    ;CHECK TARGET LIMITS
07541 162432           SUBZ# 3,0,SZC ; OK IF BETWEEN MLIM & PLIM
07542 000405           JMP WAIT
07543 034417           LDA 3,PLIM
07544 162032           ADCZ# 3,0,SZC
07545 000740           JMP E3         ; NO SUCH BLOCK
07546 074474           DIA 3,LINC     ;CLEAR SYNC FLOP
07547 063474  WAIT:    SKPBN LINC     ;GET BLOCK #
07550 000777           JMP WAIT
07551 063774           SKPDZ LINC
07552 000774           JMP WAIT-1     ;WAS A CHECK MARK
07553 074474           DIA 3,LINC     ;INPUT IT
07554 116543           SUBOL 0,3,SNC ;SKIP IF BELOW BLOCK WANTED
07555 010402           ISZ TEMP1
07556 002401           JMP @TEMP1
07557 000000  TEMP1:   0
07560 000000  TEMP2:   0
07561 177770  MLIM:    177770        ;LOWEST BLOCK
07562 000620  PLIM:    620           ;HIGHEST BLOCK
07563 000400  SIZE:    400           ;BLOCK LENGTH
07564 000001  C1:      1
07565 000002  C2:      2
07566 000004  C4:      4
07567 000010  C8:      10
              ;
```

^^^

```
                        ;
                        ;    WHAT FOLLOWS IS A BOOT , WHICH CAN BE
                        ;    USED TO LOAD ALL BUT ONE BLOCK OF MEMORY,
                        ;    FROM DRIVE Ø. THIS PROCEDURE IS USED BY
                        ;    THE BOOT PROG.
                        ;    JUMP TO "START" WITH:
                        ;          ACØ=FIRST BLOCK TO BE READ,
                        ;          AC1=# BLOCKS TO READ,
                        ;          AC2= LOAD ADDR.
                        ;    A HALT @ "PAUSE" INDICATES ERROR.
                        ;    IF NO ERROR, CONTROL IS PASSED TO THE
                        ;    LAST WORD LOADED, WITH :
                        ;          AC2= ADDR OF LAST WORD LOADED +1,
                        ;          AC3= ADDR OF "CLINC" IN UTILITIES.
                        ;
07570 000000  LLOC:     Ø
07571 004612            JSR   RLINC
07572 034776            LDA   3,LLOC
07573 125005            MOV   1,1,SNR
07574 001377            JMP   -1,2
07575 062677  PAUSE:    IORST           ;STOP & SELECT DRIVE Ø
07576 063077            HALT            ;IF ERROR, SET AC'S & CONTINUE
07577 000772  START:    JMP .-6         ;   SYSTEM START BLOCK
                        .END
```

APPENDIX C. KEYBOARD EXECUTIVE

LINCTAPE KEYBOARD EXECUTIVE ROUTINE 5/71

THE LINC EXECUTIVE INTERPRETS TYPED COMMANDS, AND PERFORMS LINCTAPE OPERATIONS ACCORDINGLY. THE PROGRAM MANIPULATES INTEGRAL NUMBERS OF LINC BLOCKS (256 WORDS EACH) BETWEEN TAPE AND ANY CONTIGUOUS CORE LOCATIONS.

COMMAND STRUCTURE

COMMANDS ARE OF TWO MODES:

	A,B,C,DX	GENERAL MODE
AND	Y	AUTOMATIC MODE.

SYMBOL DEFINITIONS:

A =ADDRESS, AN OCTAL DIGIT STRING, FOLLOWED BY A COMMA. THE LAST 5 DIGITS TYPED REPRESENT THE FIRST CORE ADDRESS. IF ONLY A COMMA IS TYPED, THE VALUE WILL BE INTERPRETED AS Ø.

B =BLOCK, THE FIRST BLOCK NUMBER; SAME GENERAL DEFINITION AS 'A', EXCEPT THE STRING IS INTERPRETED AS A 16-BIT SIGNED NUMBER. (2'S COMPLEMENT CONVENTION)

C =COUNT, THE COUNT OF BLOCKS TO BE PROCESSED; SAME DEFINITION, BUT A 16-BIT UNSIGNED NUMBER.

D =DRIVE, THE DRIVE NUMBER; AN OCTAL DIGIT STRING NOT FOLLOWED BY A COMMA. ONLY THE LEAST SIGNFICANT (LAST TYPED) 4 BITS ARE USED.

X =ONE OF THE FOLLOWING SINGLE CHARACTERS:

C CHECK - FIND AND VERIFY BLOCK NUMBERS AND CHECKSUMS.

R READ - FIND, CHECK AND TRANSFER INTO CORE.

W WRITE - FIND, WRITE FROM CORE, AND CHECK (TWO PASSES).

THE INTERPRETER CATCHES INVALID CHARACTERS TYPED, AND CHECKS COMMAND FORMAT, BUT IT IS POSSIBLE TO "BOMB" THE SYSTEM BY LOADING OVER THE EXECUTIVE PROGRAM, FOR EXAMPLE. THE EXECUTIVE RESIDES AT X7000-X7377 OCTAL (WHERE X7777 IS THE HIGHEST CORE LOCATION), AND IT CALLS ON THE LINC UTILITIES AT X7400-X7577 OCTAL. IN OTHER WORDS, THE MAXIMUM NUMBER OF BLOCKS YOU CAN READ IS 16 BLOCKS IN A 4K MACHINE, OR ALL BUT THE HIGHEST 1000 LOCATIONS OF CORE. THERE IS NO RESTRICTION ON CHECKING.

THE DRIVE MUST BE IN TENSION MODE AND, IF WRITING, THE DRIVE PROTECT LIGHT MUST BE OFF. IF ON, THE TAPE WILL NOT BE WRITTEN, AND AN ERROR WILL BE INDICATED.

THE EXECUTIVE MAY BE RESTARTED AS FOLLOWS:

PRESS 'RESET'
SET DATA SWITCHES TO X7000 OCTAL
PRESS 'START'

AUTOMATIC MODE

IN THE AUTOMATIC MODE, TYPING A SINGLE CHARACTER WILL READ IN THE DESIRED PROGRAM. THIS MODE WILL ONLY READ FROM DRIVE Ø. IT WILL NOT WRITE, NOR WILL IT ACCESS ANY OTHER DRIVE.

FOR INSTANCE, TYPING "A" CAN READ THE ASSEMBLER FROM THE TAPE ON DRIVE Ø INTO CORE. AS WITH THE GENERAL MODE, THE SYSTEMS RETURNS TO THE KEYBOARD EXEC AFTER READING, AND THE NORMAL START PROCEDURE FOR THAT PROGRAM MUST BE FOLLOWED TO EXECUTE IT.

THE NECESSARY INFORMATION FOR READING IS STORED IN A TABLE IN THE KEYBOARD EXEC. IT IS ASSUMED THAT THE PROPER PROGRAM WILL BE FOUND ON THE TAPE. IN GENERAL, IT IS ADVISABLE TO MAINTAIN THE TABLE IN THE KEYBOARD EXEC TO MATCH THE PROGRAMS ON THAT PARTICULAR TAPE. IN THIS WAY, THE SYSTEM, AFTER BOOTSTRAPPING, WILL FUNCTION PROPERLY.

WHEN PROGRAMS ARE ADDED TO OR DELETED FROM THE TAPE, THE KEYBOARD EXEC MUST BE UPDATED IF THE AUTOMATIC MODE IS TO HANDLE IT PROPERLY. THIS TABLE STARTS AT LOCATION YY212 (WHERE YYØØØ IS THE FIRST LOCATION IN THE EXEC). THE TABLE REQUIRES A GROUP OF FOUR PARAMETERS FOR EACH PROGRAM:

(1) KEYBOARD LETTER
(2) FIRST CORE LOCATION
(3) FIRST BLOCK NUMBER
(4) NUMBER OF BLOCKS

THE SEQUENCE OF THE GROUPS DOES NOT MATTER, BUT THE SEQUENCE OF THE PARAMETERS WITHIN THE GROUP DOES. THERE IS ROOM IN THE TABLE FOR 23 LETTERS.

THE PROCEDURE FOR CHANGING THE TABLE IS:

(1) ENTER THE EXECUTIVE ROUTINE
(2) LOAD THE DEBUG III ROUTINE
(3) PUT THE TAPE WITH THE EXECUTIVE ROUTINE THAT IS TO BE UPDATED ON DRIVE Ø
(4) READ A FRESH COPY OF THE EXEC INTO WORKING CORE (THE EXEC IS ON BLOCK -6, OR 177772):
    1ØØØ,177772,1,ØR
    NEVER TRY TO UPDATE THE EXEC "IN PLACE".
(5) ENTER THE DEBUG ROUTINE
(6) LIST THE TABLE, FROM LOCATION 1212 UNTIL THE FIRST (ASCII LETTER) WORD IN A GROUP IS ZERO, INDICATING THE END OF THE TABLE (A LOCATION ENDING IN -2 OR -6.)

(7) ADD, CHANGE, OR DELETE GROUPS IN THE TABLE AS REQUIRED. BE SURE TO PUT THE NUMBERS IN THE CORRECT SEQUENCE, AND TO PUT THE "END OF TABLE" ZERO AFTER THE LAST SET. NOTE ALSO THAT THE ASCII IS 7, NOT 8 BIT CODE. A TYPICAL SEQUENCE IS:

```
     001242  000113   ASCII LETTER K
     001243  001000   1ST CORE LOCATION
     001244  000030   1ST BLOCK NUMBER
     001245  000014   NUMBER OF BLOCKS
     001246  000000   END OF TABLE
```

THE TABLE CAN, OF COURSE, BE UPDATED BY OTHER MEANS, SUCH AS THE FRONT PANEL SWITCHES.

(8) WRITE THE UPDATED VERSION BACK ONTO LINCTAPE:

```
     1000,177772,1,0W
```

(9) REBOOT, AND TEST THE NEW ROUTINE.

TO EXECUTE ANY LOADED PROGRAM, YOU MUST FOLLOW NORMAL INSTRUCTIONS FOR THAT PROGRAM. THE LINC EXEC DOES NOT START PROGRAMS.

ERRORS ARE INDICATED BY A RETURN TO THE EXECUTIVE WITH ? TYPED, THEN *
ERRORS CAN BE :
1. TAPE NOT IN TENSION.
2. TAPE PROTECTED AGAINST WRITE.
3. CHECKSUM ERROR; YOU HAVE A BAD BLOCK ON TAPE, OR YOU PRESSED PROTECT SWITCH WHILE WRITING. RETRY.
4. BAD TAPE, NEEDS REMARKING.
5. YOU TRIED TO FIND A BLOCK NOT ON THE TAPE. LIMITS ARE 177772 (-6) THROUGH 0, TO 617, OCTAL.
6. INVALID COMMAND.

SUCCESSFUL COMPLETION OF A COMMAND IS INDICATED BY A RETURN TO THE EXECUTIVE WITH * TYPED.

EXAMPLES

```
*100,2,1,0R
*               READ, STARTING AT CORE ADDRESS 100,
                ONE BLOCK, STARTING AT BLOCK 2, DRIVE 0.

*0,77777777777,1,1W
*                    WRITE BLOCK -1 FROM CORE ADDR 0,DRIVE 1

*0,177777,1,1W
?
*               ERROR. SAME COMMAND AS ABOVE.

*0,0,620,0C     CHECK TAPE BLOCKS 0 THROUGH 617.
*,,620,0C       SAME THING.

*A
*               LOAD EXTENDED ASSEMBLER.
```

THIS ROUTINE IS LISTED AS ASSEMBLED AT LOCATION 7000.
EXCEPT FOR THE POINTERS, WHICH ARE PRESET AT BOOT TIME, IT IS
POSITION INDEPENDENT, AND WILL BE THE SAME FOR ANY SIZE CORE.

```
                ;                KEYBOARD EXEC              5/71/JJM

                ;       THESE ROUTINES ALLOW THE USER TO USE THE LINC
                ;       TAPE UTILITIES FROM THE KEYBOARD.
                ;       THIS PROGRAM ACCEPTS TWO TYPES OF COMANDS
                ;       TYPE 1 IS THE SINGLE LETTER TYPE WHICH IS USED
                ;       PRIMARILY TO READ IN SYSTEM PROGRAMS FROM
                ;       DRIVE 0 ONLY.   THE PROGRAM CONTAINS A LOOKUP
                ;       TABLE FOR THESE COMMANDS WHICH CAN BE EASILY
                ;       UPDATED WITH DEBUGER.
                ;       THE TYPE TWO COMANDS ARE READ, WRITE AND
                ;       CHECK.  THESE COMMANDS REQUIRE 4 PARAMETERS
                ;       AS EXPLAINED IN THE INSTRUCTION BOOK


        007000          .LOC    7000

07000 000504    EXEC:   JMP     ELIN    ; OUTPUT CR "*
07001 102400            SUB     0,0     ; CLEAR AC0
07002 040571            STA     0,TEM1  ; CLEAR INPUT ARRAY
07003 040571            STA     0,TEM2
07004 040571            STA     0,TEM3
07005 040571            STA     0,TEM4
07006 020552            LDA     0,C4    ; SET RE-TRY COUNT
07007 040571            STA     0,ERCO
07010 004503            JSR     INOC    ; INPUT OCTAL NUMBER
07011 044562            STA     1,TEM1
07012 030552            LDA     2,C54   ; COMA??
07013 142415            SUB#    2,0,SNR
07014 000422            JMP     COMA


07015 024543            LDA     1,C4    ; LOOK UP INPUT CHARACTER
07016 034573            LDA     3,TABL
07017 031400    EAGN:   LDA     2,0,3
07020 151005            MOV     2,2,SNR ; IF END OF TABLE GRIPE
07021 000457            JMP     NOGO
07022 142415            SUB#    2,0,SNR ; IF MATCH GO TO IT
07023 000403            JMP     FNDI
07024 137000            ADD     1,3     ; UPDATE POINTER
07025 000772            JMP     EAGN    ; AND TRY AGAIN


07026 021401    FNDI:   LDA     0,1,3   ; GET PARAMETERS AND SAVE THEM
07027 040544            STA     0,TEM1
07030 021402            LDA     0,2,3
07031 040543            STA     0,TEM2
07032 021403            LDA     0,3,3
07033 040542            STA     0,TEM3
07034 020536            LDA     0,CR
07035 000414            JMP     COM1-1  ; GO TO IT
```

^^^

```
07036 004455  COMA:   JSR     INOC     ; GET NEXT NUMBER
07037 044535          STA     1,TEM2   ; SAVE IT
07040 030524          LDA     2,C54    ; CHECK FOR COMA
07041 142414          SUB#    2,0,SZR
07042 000436          JMP     NOGO
07043 004450          JSR     INOC     ; GET NEXT NUMBER
07044 044531          STA     1,TEM3
07045 142404          SUB     2,0,SZR
07046 000432          JMP     NOGO
07047 004444          JSR     INOC
07050 044526          STA     1,TEM4
07051 034530          LDA     3,TABL1  ; LOOK UP CHARACTER
07052 031400  COM1:   LDA     2,0,3
07053 175400          INC     3,3
07054 175400          INC     3,3
07055 151015          MOV#    2,2,SNR
07056 000422          JMP     NOGO     ; IF END OF TABLE GRIPE
07057 142414          SUB#    2,0,SZR
07060 000772          JMP     COM1     ; IF NOT MATCH TRY AGAIN
07061 035777          LDA     3,-1,3   ; GET EXECUTION ADDRESS
07062 054515          STA     3,FDDR   ; SAVE EXEC ADDRESS


07063 020511  TRYAGN: LDA     0,TEM2   ; STARTING BLOCK #
07064 024511          LDA     1,TEM3   ; NUMBER OF BLOCKS
07065 030511          LDA     2,TEM4   ; DRIVE #
07066 072074          DOB     2,74     ; SELECT DRIVE
07067 030504          LDA     2,TEM1   ; STARTING CORE LOCATION
07070 034507          LDA     3,FDDR   ; GET EXECUTION ADDRESS
07071 005400          JSR     0,3      ; GO TO IT
07072 125015          MOV#    1,1,SNR  ; IF NO ERROR RETURN TO START
07073 000705          JMP     EXEC
07074 125223          MOVZR   1,1,SNC  ; IF CHECKSUM TRY AGAIN
07075 000403          JMP     NOGO     ; ELSE GIVE UP
07076 014502          DSZ     ERCO
07077 000764          JMP     TRYAGN   ; TRY THREE TIMES


07100 020462  NOGO:   LDA     0,C15
07101 004447          JSR     OA0
07102 020466          LDA     0,CQUES
07103 004445          JSR     OA0
07104 020456  ELIN:   LDA     0,C15
07105 004443          JSR     OA0
07106 020463          LDA     0,CSTAR
07107 004441          JSR     OA0
07110 020453          LDA     0,C40
07111 004437          JSR     OA0
07112 000667          JMP     EXEC+1
```

^^^

```
                ;       CONVERT AN ASCII OCTAL CHARACTER STRING TO A BINARY
                ;       NUMBER IN AC1, AND A BREAK CHARACTER IN AC0

07113 054425    INOC:   STA     3,RTRN  ; SAVE RETURN ADDRESS
07114 050425            STA     2,TEM0  ; SAVE AC2
07115 102400            SUB     0,0
07116 040424            STA     0,OCTL  ; CLEAR RESULT WORD
07117 004424    INOC1:  JSR     IA0     ; GET A CHARACTER
07120 030445            LDA     2,C60
07121 034445            LDA     3,C67
07122 162033            ADCZ#   3,0,SNC ; TEST FOR 60<=N<=67
07123 112032            ADCZ#   0,2,SZC
07124 000411            JMP     EINOC   ; NO MUST BE BREAK CHARACTER
07125 142400            SUB     2,0     ; MAKE IT OCTAL
07126 024414            LDA     1,OCTL
07127 125120            MOVZL   1,1     ; OLD TIMES 8
07130 125120            MOVZL   1,1
07131 125120            MOVZL   1,1
07132 107000            ADD     0,1     ; NEW PLUS OLD
07133 044407            STA     1,OCTL
07134 000763            JMP     INOC1   ; LOOP UNTIL BREAK CHARACTER

07135 030404    EINOC:  LDA     2,TEM0  ; RESTORE AC2
07136 024404            LDA     1,OCTL  ; RESULT TO AC1
07137 002401            JMP     @RTRN

07140 000000    RTRN:   0               ; SAVE RETURN LOCATION
07141 000000    TEM0:   0               ; STORAGE FOR AC2
07142 000000    OCTL:   0               ; RESULT


                ;       INPUT AND ECHO TELETYPE CHARACTER AND MASK PARITY

07143 063610    IA0:    SKPDN   TTI     ; WAIT FOR INPUT CHARACTER
07144 000777            JMP     .-1
07145 060610            DIAC    0,TTI   ; INPUT CHARACTER TO AC0
07146 030421            LDA     2,C177  ; MASK OFF PARITY BIT
07147 143400            AND     2,0

07150 063511    OA0:    SKPBZ   TTO     ; WAIT FOR OUTPUT       READY
07151 000777            JMP     .-1
07152 061111            DOAS    0,TTO   ; OUTPUT AC0 AND START
07153 030407            LDA     2,C15
07154 142434            SUBZ#   2,0,SZR ; IF CR OUTPUT LF
07155 001400            JMP     0,3
07156 020403            LDA     0,C12
07157 000771            JMP     OA0
```

^^^

```
                        ;       CONSTANTS
07160  000004   C4:     4
07161  000012   C12:    12
07162  000015   C15:    15
07163  000040   C40:    40
07164  000054   C54:    54
07165  000060   C60:    60
07166  000067   C67:    67
07167  000177   C177:   177
07170  000077   CQUES:  "?
07171  000052   CSTAR:  "*
07172  000122   CR:     "R
07173  000000   TEM1:   0
07174  000000   TEM2:   0
07175  000000   TEM3:   0
07176  000000   TEM4:   0
07177  000000   FDDR:   0
07200  000000   ERCO:   0
```

^^^

```
                ;       VALUES IN THIS TABLE WILL BE FILLED IN BY THE
                ;       SIZE ROUTINE AT LOAD TIME
07201 000000    TABL1:  0                       ; ADDRESS OF TABLE
07202 000122            "R                      ; READ LINC TAPE
07203 000000    LR:     0
07204 000103            "C
07205 000000    LC:     0
07206 000127            "W
07207 000000    LW:     0
07210 000000            0                       ; END OF TABLE


                ;       AUTOMATIC MODE TABLE
                ;       THIS TABLE IS USED TO LOOK UP THE
                ;       STARTING CORE LOCATION, STARTING BLOCK #
                ;       AND THE NUMBER OF BLOCKS FOR THE SINGLE
                ;       LETTER COMMANDS.

                ;       THE FORM IS:
                ;         COMMAND LETTER
                ;         STARTING CORE LOCATION
                ;         STARTING BLOCK NUMBER
                ;         NUMBER OF BLOCKS
                ;
                ;       THUS:
                ;        07212  000104   "D
                ;        07213  001000   1000
                ;        07214  000000   0
                ;        07215  00014   14
                ;        07216  000000   0
                ;       WOULD LOAD LOCATIONS 1000 THRU 6777 INTO CORE
                ;       FROM BLOCKS 0 THRU 13 ON THE TAPE ON DRIVE 0,
                ;       WHEN THE LETTER "D" WAS TYPED.
                ;
                ;       THERE IS ROOM IN THE TABLE FOR 23 (DECIMAL)
                ;       COMMAND LETTERS.
                ;


07211 000000    TABL:   0                       ; ADDRESS OF TABLE
07212 000000            0                       ; END OF TABLE
```

^^^

```
                ;       THIS ROUTINE DETERMINES THE SIZE OF CORE AND
                ;       SETS ALL OF THE POINTERS.

      007352            .LOC    EXEC+352
07352 024421  SIZE:     LDA     1,C400
07353 132400            SUB     1,2
07354 141000            MOV     2,0
07355 024421            LDA     1,TABP
07356 133000            ADD     1,2
07357 051377            STA     2,-1,2
07360 024415            LDA     1,TAB2P
07361 133000            ADD     1,2
07362 051377            STA     2,-1,2
07363 054622            STA     3,LC
07364 024410            LDA     1,C3
07365 137000            ADD     1,3
07366 054615            STA     3,LR
07367 137000            ADD     1,3
07370 054617            STA     3,LW
07371 111000            MOV     0,2
07372 001000            JMP     0,2
07373 000400  C400:     400
07374 000003  C3:       3
07375 000010  TAB2P:    TABL-TABL1
07376 000202  TABP:     TABL1-EXEC+1
07377 000753            JMP     SIZE
                        .END
```

APPENDIX D. LINCTAPE MAP

STANDARD LINCTAPES FOR USE WITH THE NOVA COMPUTERS CONTAIN THE FOLLOWING PROGRAMS:

BLOCK NUMBER	PROGRAM
-10	PRELOADER (BYTE FORM)
-7	UTILITY LOADER (BYTE FORM) LINCTAPE UTILITIES
-6	KEYBOARD EXECUTIVE
-5 THRU -1	ZEROES